TAKAGI

# T-M1 / T-M199

## On-Demand Water Heater

## Service manual

**Mobius Water Heater™**
**Model T-M1**

**Mobius Water Heater™**
**Model T-M199**

**TAKAGI Industrial Co. USA, Inc.**

5 Whatney

Irvine, CA 92618

Toll Free: (888) 882-5244 USA

Toll Free: (877) 877-4953 CANADA

## Content

1. Specifications of the T-M1,T-M199 and the T-M1..... 3
2. Exterior view..... 4
3. Interior view..... 6
4. List of main components in the interior view..... 7
5. Schematic diagram..... 9
6. Wiring diagram..... 10
7. Wiring diagram checkpoints for diagnosis..... 11
8. Resistance values of the temperature thermistors..... 14
9. Operational flow chart..... 15
10. Component specifications ..... 16
11. Fault Analysis & Specifications..... 41
12. Controls and settings..... 52
13. Components diagrams..... 81
14. Parts list ..... 85
15. Revisions ..... 90

## 1. Specifications of the T-M1, T-M199 and T-K3

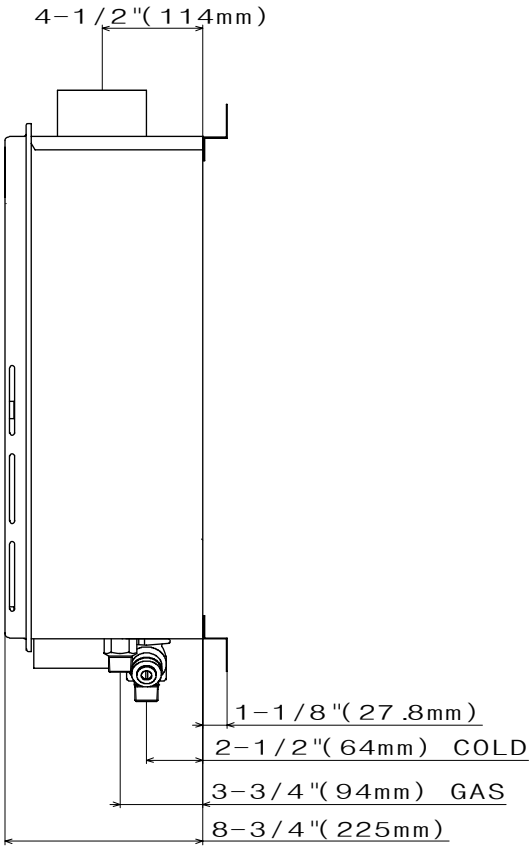
| Model | | | T-M1 | T-M199 | T-K3 |
|---|---|---|---|---|---|
| Dimensions | | | H23.6"×W18.5"×D8.9" | | H20.5"×W13.8"×D8.5" |
| Weight | | | 70lbs. | | 40lbs. |
| Combustion | INPUT BTU/h | Max | LP 225,000<br>Natural 235, 000 | | 199,000 |
| | | Min | 25,000 | | 11,000 |
| | Combustion System | | Power vent | | Power vent |
| | Installation | | Indoor & Outdoor | Indoor, Outdoor, & Direct-vent | Indoor, Outdoor, & Direct-vent |
| | Fan motor | | PWM turbo fan | | PWM turbo fan |
| | Manifold Pressure* | Max | LP 2.7" WC*<br>Natural 2.2" WC* | LP 2.2" WC*<br>Natural 1.8" WC* | LP 4.3" WC*<br>Natural 2.5" WC* |
| | | Min | LP 0.6" WC*<br>Natural 0.5" WC* | LP 0.6" WC*<br>Natural 0.5" WC* | LP 0.7" WC*<br>Natural 0.4" WC* |
| Water control | Flow rate | | 0.75GPM to 9.0GPM | | 0.5 GPM to 7.0 GPM |
| | Available set temperatures | | 99°F ～ 182°F<br>Default: 122°F | | 99°F ～ 185°F<br>default: 122°F |
| | Temperature dipswitch settings | | 113°F, 122°F, 140°F, 182°F | | 104°F, 113°F, 122°F, 131°F, 140°F, 158°F, 176°F, 185°F |
| | Bypass valve | | Yes | | Yes |
| | Two-way valve | | Yes | | No |
| | Thermistors | | 3 thermistors (In, Out, Mixing) | | 3 thermistors (In, Out, Mixing) |
| Operation | Remote controller model | | TM-RE10,TM-RE30 | | TM-RE10<br>TM-RE30 |
| | PCB model | | T-M1/T-M199 | | T-K3 |
| | Indicators | | "Burning" LED "Operating LED" & 7SEG LED | | "Burning" LED & 7-SEG LED |
| | Power supply control | | GFI and Surge absorber | | GFI (Including surge absorber) |
| Features | Freeze protection | | Ceramic heaters and Auto-FM system | | Ceramic heaters and Auto-firing system |
| | Self-combustion improvement | | Thermo-couple detection system | | Air Fuel Ration detection system |
| | Easy-Link system | | N/A | | Yes |
| | Multiple-system | | Yes | | N/A |

*The manifold pressure measurement is base on conditions without front cover.

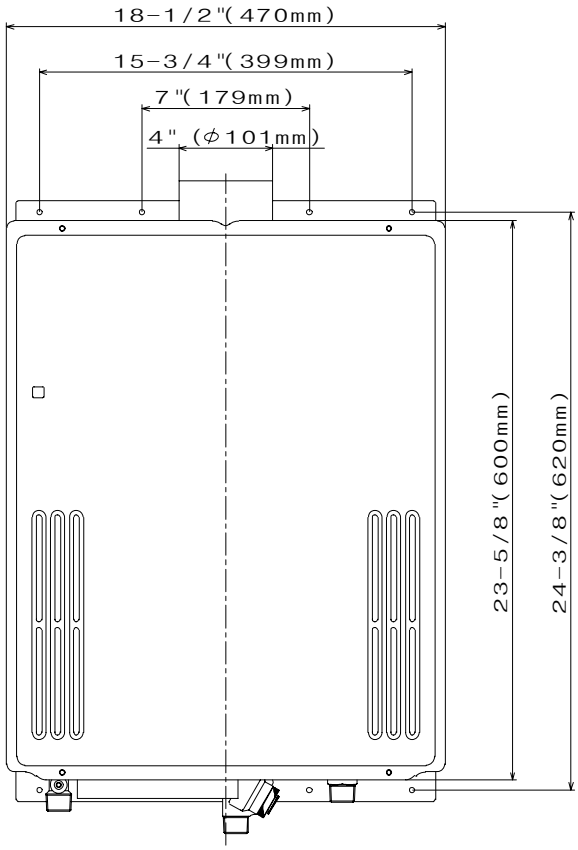
## 2. Exterior view

Other than the **front cover** and **case assembly**, the T-M1 and T-M199 share the same components.

Side view

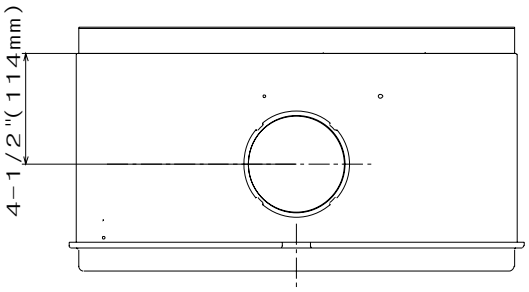



Front view

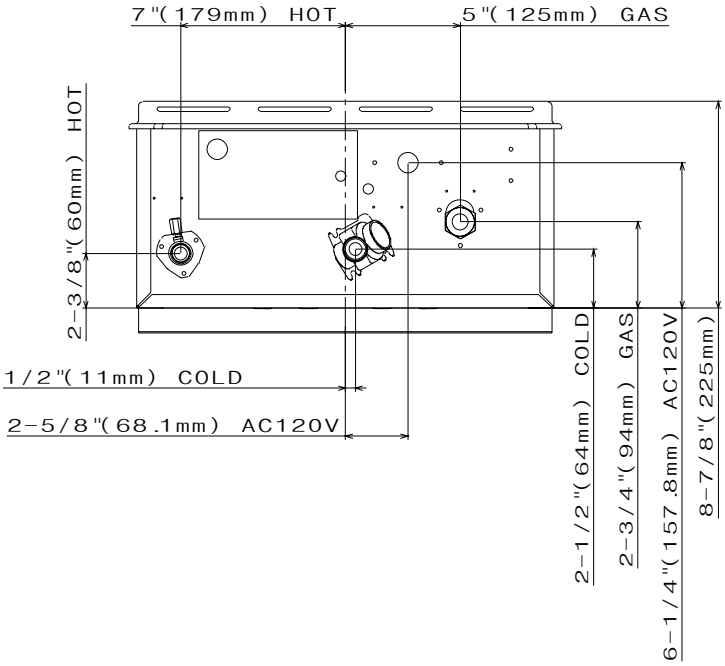


**T-M1**

Top view

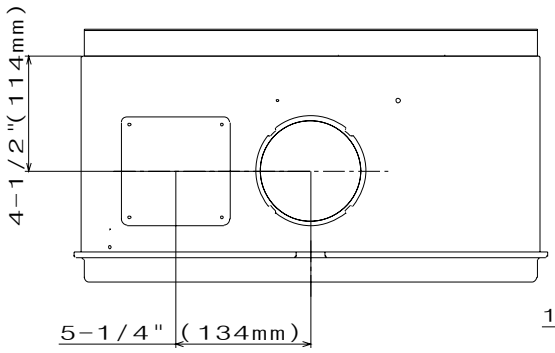



Bottom view

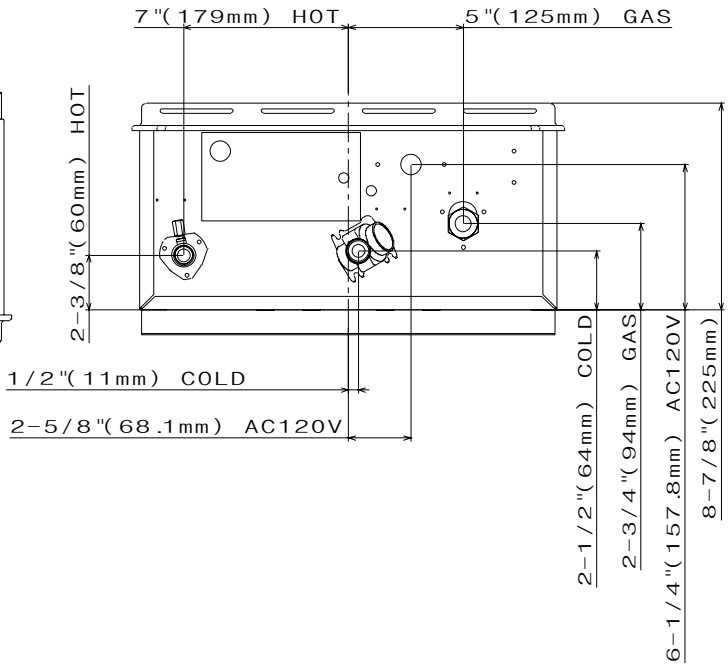



**T-M199**

Top view

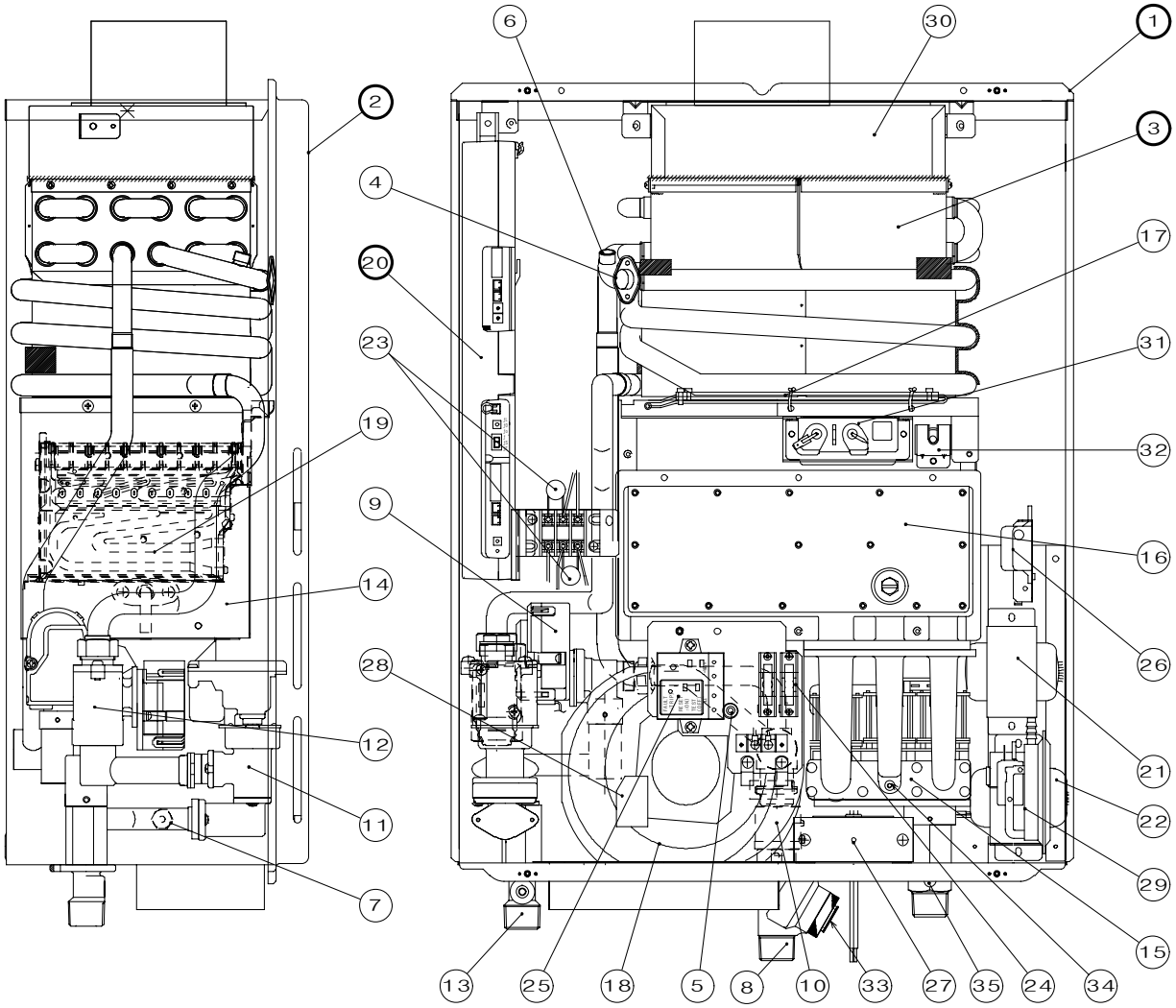



Bottom view



### 3. Interior view

Other than the **case assembly (No.1)**, **front cover assembly (No.2)**, **heat exchanger (No.3)** and **computer board (No.20)**, the T-M1 and T-M199 share the same components.



## 4. List of main components in the internal view

Other than the **case assembly (No.1)**, **front cover assembly (No.2)**, **heat exchanger (No.3)** and **computer board (No.20)**, the T-M1 and T-M199 share the same components.

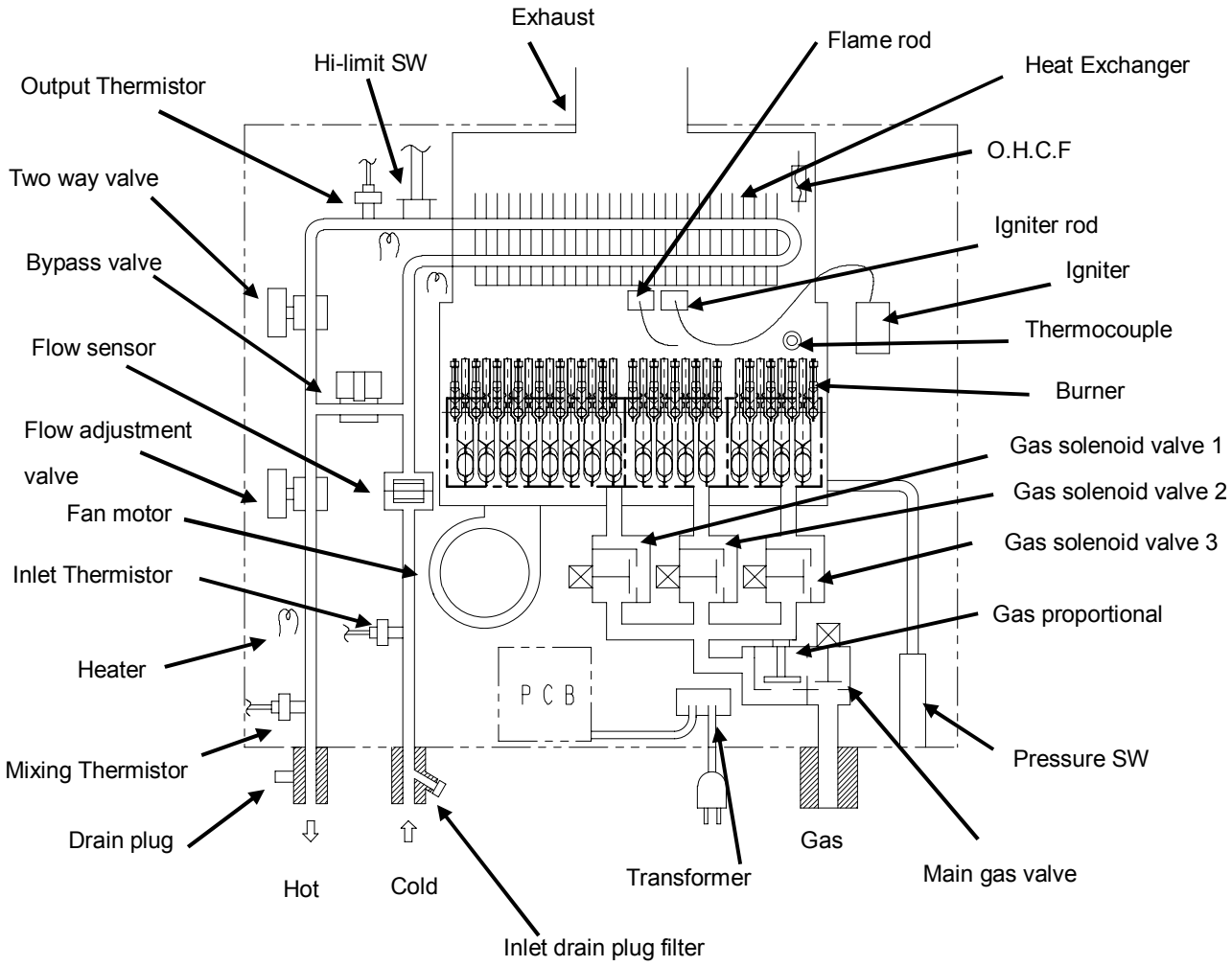
| No. | Description | T-M1,T-M199 Part# | Takagi Part # | Common parts For other units |
|---|---|---|---|---|
| **1** | **Case assembly** | **001** | **EM103 (T-M1)**<br>**EM232 (T-M199)** | |
| **2** | **Front cover assembly** | **013** | **EM105 (T-M1)**<br>**EM233 (T-M199)** | |
| **3** | **Heat Exchanger assembly** | **015** | **EM112 (T-M1)**<br>**EM240 (T-M199)** | |
| 4 | Hi-limit switch | 016 | EM212 | TK2,TKD20 |
| 5 | Inlet thermistor | 027 | EM187 | TK2, TKD20 |
| 6 | Output thermistor | 019 | EM186 | |
| 7 | Mixing thermistor | 044 | EM179 | |
| 8 | Water inlet | 064 | EM101 | |
| 9 | Bypass valve | 051 | EM116 | |
| 10 | Flow sensor | 059 | EM143 | |
| 11 | Flow adjustment valve | 037 | EM120 | |
| 12 | Two way valve | 030 | EM118 | |
| 13 | Water outlet | 064 | EM101 | |
| 14 | Combustion chamber | 068 | EM121 | |
| 15 | Gas Valve Unit | 103 | EM122 | TH1 |
| 16 | Manifold assembly | 091<br>091 | EM162 (LP)<br>EM158 (NG) | |
| 17 | Overheat cut-off fuse | 025 | EM138 | |
| 18 | Fan motor | 087 | EM126 | |
| 19 | Burner assembly | 069 | EM197 | |
| **20** | **Computer board** | **111** | **EM129 (T-M1)**<br>**EM235 (T-M199)** | |

## 4. List of main components in the internal view

| No. | Description | T-M1,T-M199 Part# | Takagi Part # | Common parts For other units |
|---|---|---|---|---|
| 21 | Computer transformer TD1-205 | 005 | EM164 | |
| 22 | Transformer TD1-203 | 006 | EM163 | |
| 23 | Surge absorber | 118<br>119 | EM182<br>EM183 | |
| 24 | Fuse | 125 | EM168 | |
| 25 | GFI | 123 | EM207 | TH1,TM32,TM50 |
| 26 | Igniter | 099 | EM208 | TK2, TKD20, TK1 |
| 27 | Junction box assembly | 007 | EK061 | TK2, TKD20 |
| 28 | Freeze protection thermostat | 090 | EM142 | |
| 29 | Pressure Switch | 086 | EKD08 | TK2, TKD20,TH1 |
| 30 | Exhaust plate assembly | See the “Heat Exchanger assembly” in the p.5 | | |
| 31 | Rod assembly | 073 | EM199 | |
| 32 | Thermocouple | 079 | EM202 | |
| 33 | Inlet drain plug (water filter) | 066 | EM222 | TM32,TM50 |
| 34 | Manifold port | N/A | N/A | |
| 35 | Gas inlet port | N/A | N/A | |

## 5. Schematic diagram

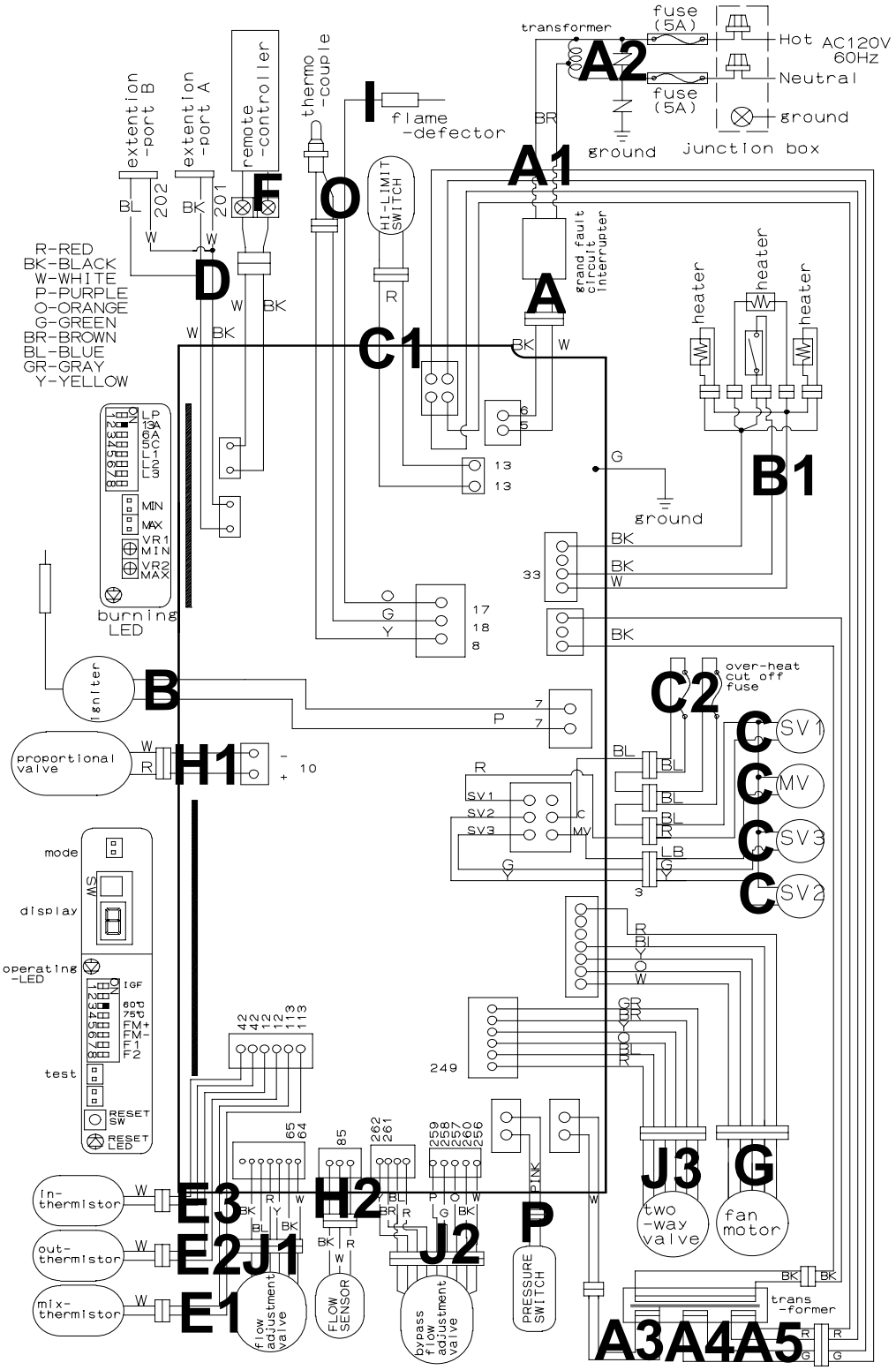
The diagram below refers to both T-M1 and the T-M199.




1. When a hot water tap is opened, cold water enters the T-M1 or T-M199 water heater.
2. The water flow sensor detects this water flow and sends this information to computer.
3. The computer initiates fan motor and sends signal to igniter to create ignition spark.
4. The main, proportional, and solenoid gas valves open to allow gas input.
5. The gas ignites and flames appear inside the burner chamber.
6. Water circulates through the heat exchanger and is heated up to the set temperature.
7. Using thermistors to measure temperatures, the computer modulates the gas and water valves to ensure proper output water temperatures.
8. When the tap is closed, the T-M1 or T-M199 water heater shuts down.

## 6. Wiring diagram

The diagram below refers to both the T-M1 and the T-M199.



## 7. Wiring diagram check points for diagnosis

The table below applies to both the T-M1 and the T-M199.

| Check-point | Part and Description | Color of wires | Normal range |
|---|---|---|---|
| A | 100V Power supply | White – Black | AC90～110V |
| A1 | 100V Power supply | Brown – Brown | AC90～110V |
| A2 | 120V Power supply | White – Black | AC108～132V |
| A3 | AC15V Line (Fan motor) | White – White | AC10～15V<br>10～20Ω |
| A4 | AC20V Line (Control source in the computer board) | Green – Green | AC15～25V<br>0.4～0.8Ω |
| A5 | AC55V Line (Flame rod) | Red – Red | AC45～65V<br>42～62Ω |
| B | Igniter | Purple – Purple | AC90～110V |
| B1 | Heater | Black – White | AC90～110V |
| C | Gas valves | Light blue - blue at COM (MV) | DC 78～100V(during operation)<br>0.9～1.7kΩ |
| | | Red - blue at COM (SV1) | DC 78～100V(during operation)<br>0.9～1.7kΩ |
| | | Yellow - blue at COM (SV2) | DC 78～100V(during operation)<br>0.9～1.5kΩ |
| | | Green - blue at COM (SV3) | DC 78～100V(during operation)<br>0.9～1.7kΩ |
| C1 | Hi-limit switch | Red - Red | Less than DC 1V<br>and<br>less than 1.0Ω |
| C2 | Overheat cutoff fuse | Blue - Blue | Less than DC 78～100V<br>and<br>less than 1.0Ω |

| Check Point | Parts and Description | Color of wires | Normal Range |
|---|---|---|---|
| D | Multi system connectors | Blue – White<br>Black – White | DC14～16V<br>(Only Installed the TM-RE20 or TM-MC01)<br>0V<br>(No multiple system) |
| E1 | Mixing thermistor | White - White | See table on p.14 |
| E2 | Output thermistor | White – White | |
| E3 | Inlet thermistor | White - White | |
| F | Remote controller | Black - White | DC14～16V |
| G | Fan motor | Red - Blue | DC100～160V |
| | | Yellow - Blue | DC14～16V |
| | | Orange - Blue | DC2.3～5.0V |
| H1 | Gas proportional Valve | White - Red at COM | DC 0.3～6.4V(during burning)/ 60～85Ω |
| H2 | Flow sensor | Red - Black | DC4～5.5V |
| | | White(+) – Black(GND) | DC1～4V (1,200Pulse/min) |
| I | Flame rod | Orange - Green | (Stand-by) AC25～65V<br>(Burning) AC20～55V |
| | | Orange – Flame rod (Between flame rod and the computer board) | (Stand-by) Less than DC0.15μA<br>(Burning) More than DC1μA |

| Check Point | Parts and Description | Color of wires | Normal Range |
|---|---|---|---|
| J1 | Flow adjustment valve | White – Black<br>White – Black<br>Yellow – Black | DC 10.0～13.0V<br>15～30Ω<br>Less than DC1V |
| J2 | Bypass flow adjustment valve | White – Blue<br>Blue – Black<br>White – Black<br>Blue – Orange<br>White – Orange<br>Blue – Green<br>White – Green<br>Blue – Purple<br>White – Purple<br>Red – Blue<br>Brown – Blue<br>Yellow – Blue | DC12.0～14.5V<br>DC1.0～14.5V<br>27～33Ω<br>DC1.0～14.5V<br>27～33Ω<br>DC1.0～14.5V<br>27～33Ω<br>DC1.0～14.5V<br>27～33Ω<br>DC12.0～14.5V<br>Less than DC1V (Opened position)<br>DC4.5～5.5V |
| J3 | Two way valve | Red – Blue<br>Orange – Gray<br>Yellow – Gray<br>Brown – Gray | DC10.0 ～13.0V (during burning)<br>DC14.0 ～16.0V (during burning)<br>Less than DC1V (opened position)<br>Less than DC1V (closed position) |
| O | Thermocouple | Green – Yellow | DC1～9mV (during the maximum and normal burning)<br>More than 9mV (abnormal burning) |
| P | Pressure switch | Pink – Pink | 4.0～5.5V (Normal)<br>Less than 1.0V (abnormal)<br>Less than 1.0Ω (abnormal) |

## 8. Resistance values of the temperature thermistors

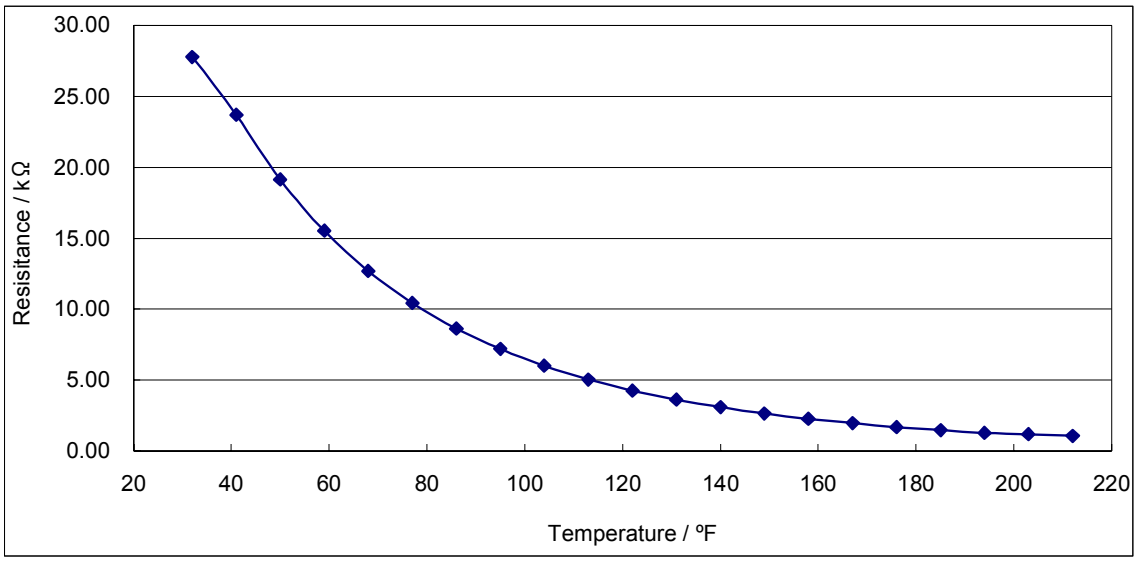
The T-M1 and T-M199 use the same thermistors.

### Resistance values at different temperatures

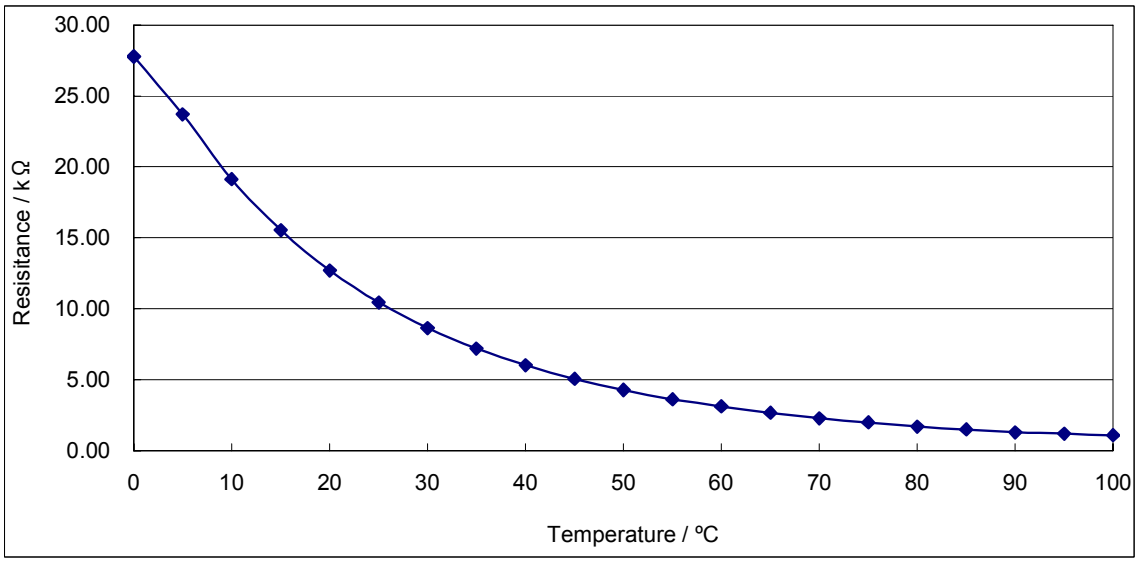
| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature | ºF | 32 | 41 | 50 | 59 | 68 | 77 | 86 | 95 | 104 | 113 |
| | ºC | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 |
| Resistance | kΩ | 27.78 | 23.70 | 19.13 | 15.53 | 12.70 | 10.44 | 8.64 | 7.19 | 6.01 | 5.05 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature | ºF | 122 | 131 | 140 | 149 | 158 | 167 | 176 | 185 | 194 | 203 | 212 |
| | ºC | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 |
| Resistance | kΩ | 4.27 | 3.62 | 3.09 | 2.64 | 2.27 | 1.96 | 1.69 | 1.47 | 1.28 | 1.18 | 1.07 |

**Temperature(°F) vs. Resistance(kΩ)**

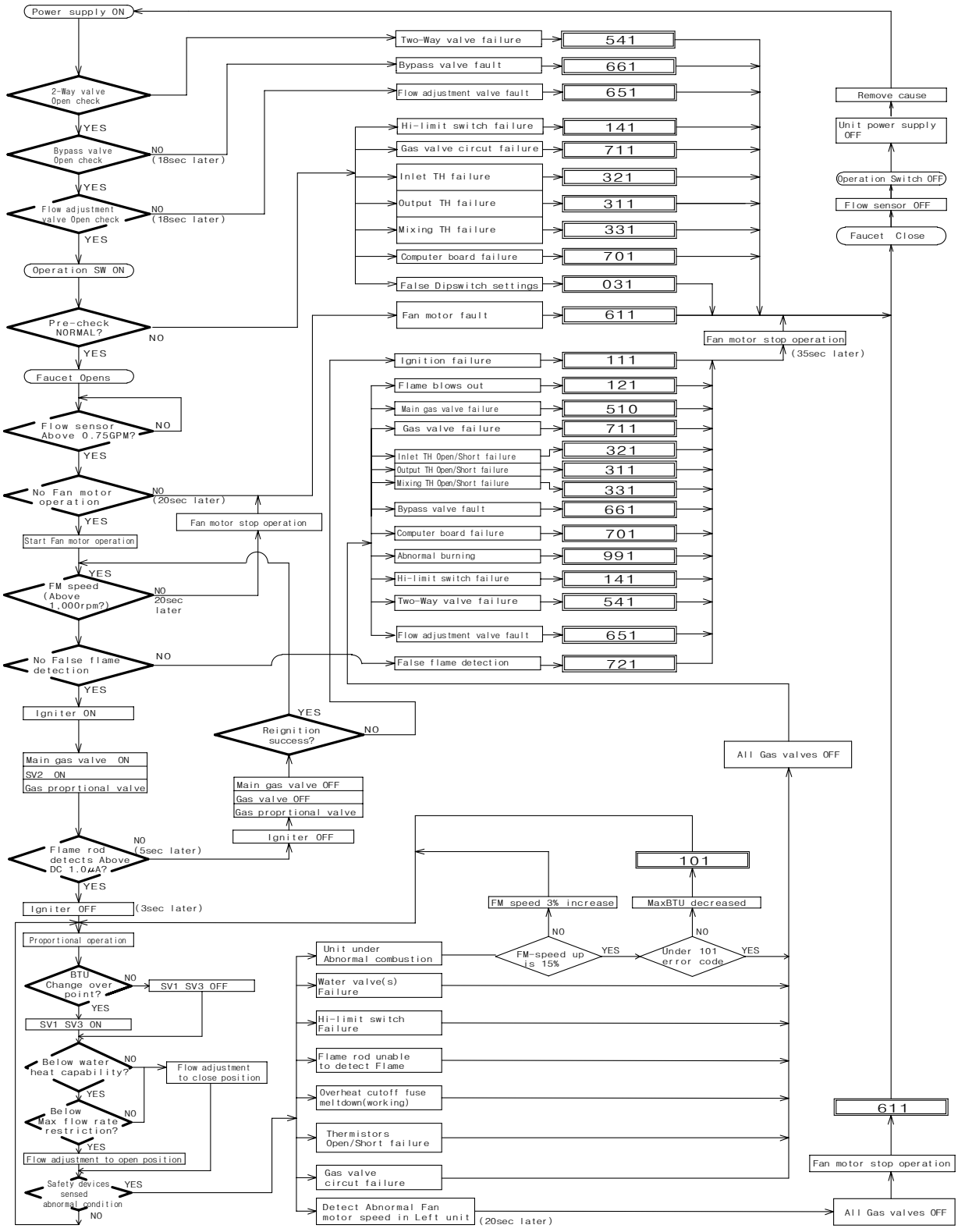



**Temperature(°C) vs. Resistance(kΩ)**



## 9. Operational flow chart

The diagram below refers to both T-M1 and the T-M199.



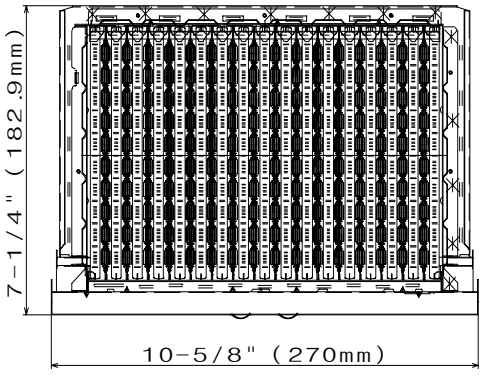
## 10. Component specifications

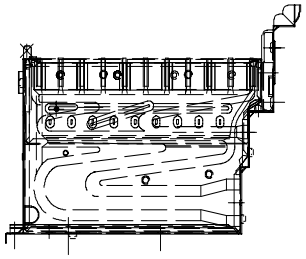
Other than the Heat exchanger (10-6) and Computer board (10-13), the T-M1 and T-M199 share the same components.

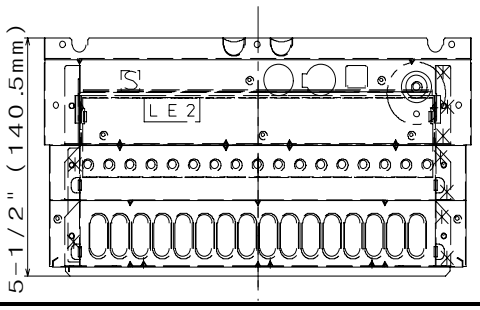
10-1. Burners…… 17
10-2. Gas manifold…… 18
10-3. Fan motor…… 19
10-4. Gas valve assembly…… 20
10-5. Flame rod…… 21
10-6. Heat exchanger…… 22
10-7. Flow adjustment valve…… 23
10-8. Flow sensor…… 24
10-9. Bypass valve…… 25
10-10. Two way valve…… 27
10-11. Thermistors …… 28
10-12. Freeze protection heaters…… 29
10-13. Computer board…… 30
10-14. Transformer…… 31
10-15. Computer transformer…… 32
10-16. GFI…… 33
10-17. Igniter…… 34
10-18. Freeze protection thermostat…… 35
10-19. Hi-limit Switch…… 36
10-20. Overheat cutoff fuse…… 37
10-21. Pressure switch…… 38
10-22. Thermocouple…… 39
10-23. Surge absorber…… 40

## 10-1. Burners

| T-M1 or T-M199 Part # | #069 | Takagi Part # | EM197 | Checkpoint | N/A |
|---|---|---|---|---|---|
| Function | There are 2 types of burners in the Water heater: the gas-rich burner stabilizes the flames within the combustion chamber and the air-rich burner produces more heat in the combustion chamber. The burners facilitate the air/gas mixture necessary to produce the proper heat during the combustion reaction. | | | | |
| Failure events | 1. Unable to initialize/sustain combustion<br>2. Dust or soot deposit on the burner surface.<br>3. Cracks on the burners.<br>4. Gas leakage from burners | | | | |
| Effects on the Water heater if burners fails | 1. An unexpected combustion.<br>2. Unstable flame conditions and/or flame loss.<br>3. Ignition failure.<br>4. Back-firing. | | | | |
| Error codes when the burners fails | **101** | **111** | **121** | **991** | |
| Diagnostic | Visual inspection: excessive dust deposit on the burner surface and/or unstable flame conditions during operation. | | | | |
| Color/Number of wires | **N/A** | | | | |



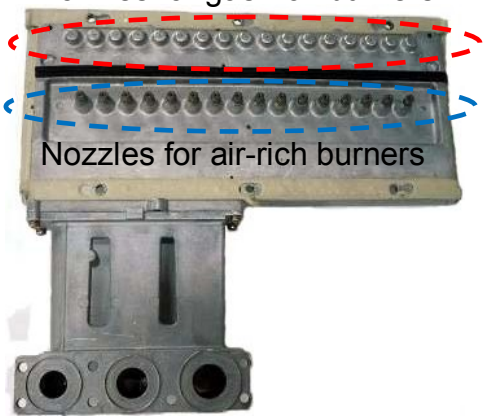



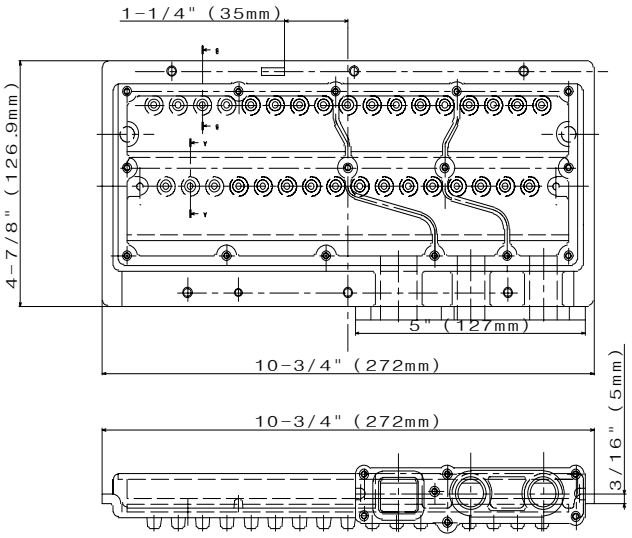


## 10-2. Gas manifold

| **T-M1 or T-M199 Part #** | #091 | **Takagi Part #** | EM162 (LP)<br>EM158 (NG) | **Checkpoint** | **N/A** |
|---|---|---|---|---|---|
| Function | 1. The manifold distributes gas from the gas valves to the burners. The manifold has two types of the nozzles: one type for gas-rich burners (17 nozzles) and the other for air-rich burners (16 nozzles)<br>2. There are 3 zones within the manifold, to ensure efficient combustion operation. | | | | |
| Failure events | 1. Dust deposit on the manifold.<br>2. Gas leakage from a failed manifold.<br>3. Ignition failure.<br>4. Imperfect combustion. | | | | |
| Effects on the Water heater if the manifold fails | 1. The burners cannot receive proper gas flow from the manifold, which can cause poor combustion in the combustion chamber. In this case, the thermocouple will detect an improper flame condition and computer will take safety measures.<br>2. Gas leakage from the manifold. | | | | |
| Error codes when the manifold fails | **101** | **111** | **121** | **991** | |
| Diagnostic | 1. Visual inspection: Excessive dust deposit around the nozzles or cracks on the manifold.<br>2. Check voltages and resistance: proper range of values shown below.<br>3. Check the inlet gas pressure. If it is too high, gas valve cannot be opened. | | | | |
| Color/Number of wires | **N/A** | | | | |

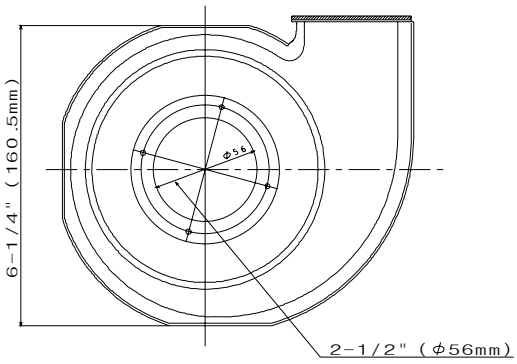
Nozzles for gas-rich burners

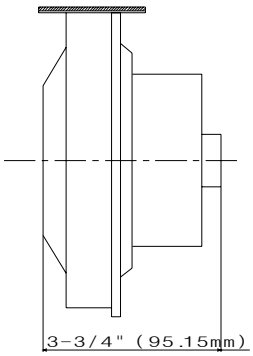


## 10-3. Fan motor

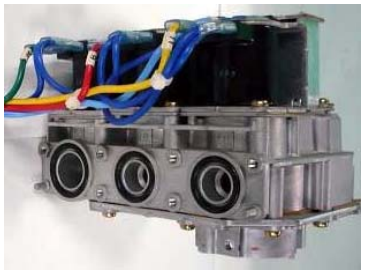
| T-M1 or T-M199 Part # | #087 | Takagi Part # | EM126 | Checkpoint | G |
|---|---|---|---|---|---|
| Function | To provide combustion air into the burner chamber and to exhaust flue gas. | | | | |
| Failure events | 1. Fan speed failure, causing abnormal sounds with or without combustion in the operation.<br>2. Unexpected working caused by the connectors of the fan motor getting wet.<br>3. Drops out from the bottom of the combustion chamber. | | | | |
| Effects on the Water heater if fan motor fails | 1. The Water heater does not function properly<br>2. Failure to ignite or abnormal ignition<br>3. Unstable combustion conditions | | | | |
| Error codes when the fan motor fails | **611** | | | | |
| Diagnostic | 1. Visual inspection: connection/breakage of wires or dust (causing electrical shortage)<br>2. Voltage check: proper range of voltages shown below. | | | | |
| Color/Number of wires | Red-Blue | DC 100～160V (Input) | | | |
| | Yellow-Blue | DC 14～16V (Input) | | | |
| | Orange-Blue | DC 2.3～5.0V (Input) | | | |
| | White-Blue | Verify the fan motor speed using the Diagnostics Mode of the TM-RE10 and the TM-RE30 temperature remote controller. See Section 12-1 for details. | | | |

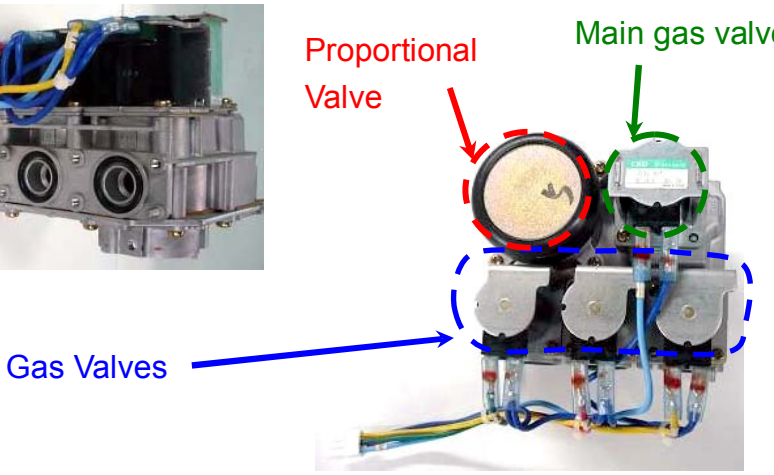


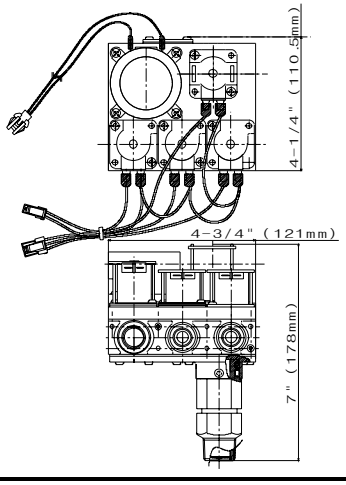



## 10-4. Gas valve assembly

| T-M1 or T-M199 Part # | #103 | Takagi Part # | EM122 | Checkpoint | C,H1 |
|---|---|---|---|---|---|
| Function | Opens and closes the gas pathways of the Water heater (main and solenoid gas valves)<br>Modulates the gas flow from the gas inlet (proportional gas valve) | | | | |
| Failure events | 1. Gas leak from the valves.<br>2. Unable to open/close (main and solenoid gas valves)<br>3. Unable to modulate the gas flow (proportional gas valve) | | | | |
| Effects on the Water heater if valves fails | 1. Gas leak from the unit.<br>2. Excess carbon monoxide emissions.<br>3. Lack of water temperature control.<br>4. No flames. | | | | |
| Error codes when the valves fails | **111** | **121** | **510** | **701** | |
| Diagnostic | 1. Visual inspection: connection/breakage of wires.<br>2. Listen for "clunk" sounds from the gas valves opening right after fan motor initiates.<br>3. Check voltages and resistance of coils; proper range of values shown below.<br>4. Check the inlet gas pressure. If it is too high, gas valve cannot be opened. | | | | |
| Color/Number of wires | Blue - Light blue (MV) | DC 78～100V (during operation) / 0.9～1.7KΩ | | | |
| | Blue - Red ($SV_1$) | DC 78～100V (during operation) / 0.9～1.7KΩ | | | |
| | Blue - Yellow ($SV_2$) | DC 78～100V (during operation) / 0.9～1.5KΩ | | | |
| | Blue - Green ($SV_3$) | DC 78～100V (during operation) / 0.9～1.7KΩ | | | |
| | White - Red (Proportional Valve) | DC 0.3～6.4V (during operation) / 60～85kΩ | | | |





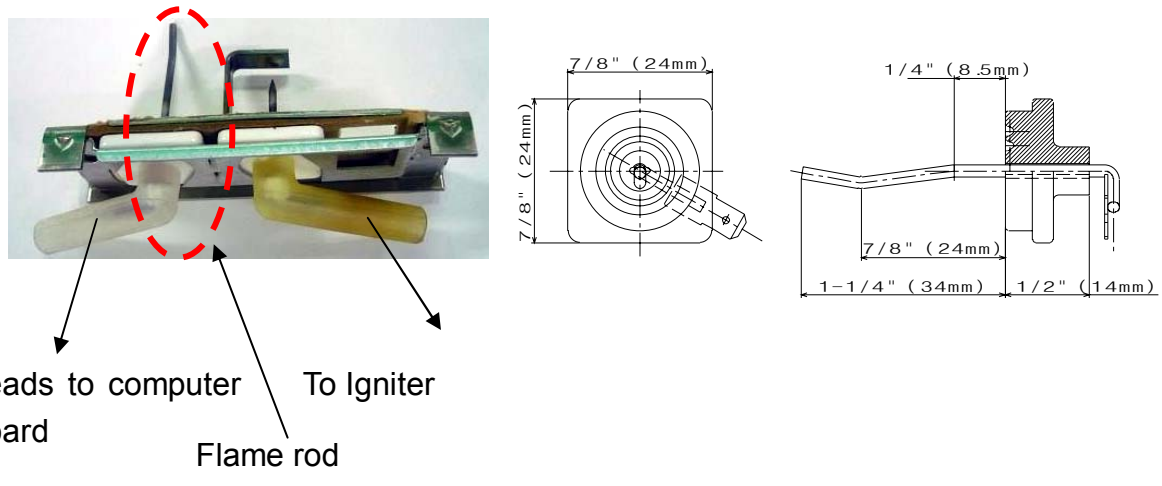



## 10-5. Flame rod

| **T-M1 or T-M199 Part #** | #073 | **Takagi Part #** | EM199 | **Checkpoint** | I |
|---|---|---|---|---|---|
| Function | To detect flames while unit is in operation. | | | | |
| Failure events | 1. Unable to detect flames when flames actually do occur<br>2. Detecting a false flame when no flames actually occur | | | | |
| Effects on the Water heater if flame rod fails | 1. The Water heater stops operating. The "111" and/or "121" error code(s) will display.<br>2. The Water heater will not initiate the ignition process. The "721" error code will display. | | | | |
| Error codes when the flame rod fails | **111** | | **121** | | **721** |
| Diagnostic | 1. Visual inspection: connection/breakage of wires or soot buildup on rod.<br>2. Check amperes: proper range of values shown below. | | | | |
| Color/Number of wires | Green - Flame rod (Between flame rod and the computer board) | | (Stand-by) AC25 to 65V<br>(Burning) AC20 to 55V | | |
| | Orange - Flame rod (Between flame rod and the computer board) | | (Stand-by) Less than DC 0.15 μA<br>(Burning) More than DC 1 μA | | |

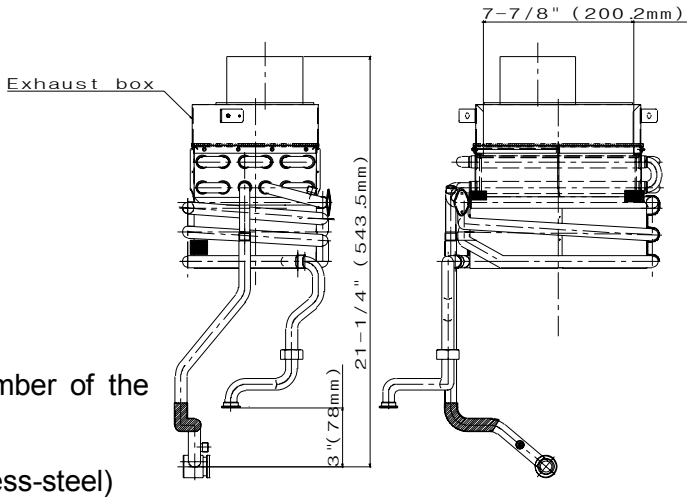
**Flame rod is included in the part# of 073 as the "Rod Assembly**

**The following picture shows the Rod Assembly**



## 10-6. Heat exchanger

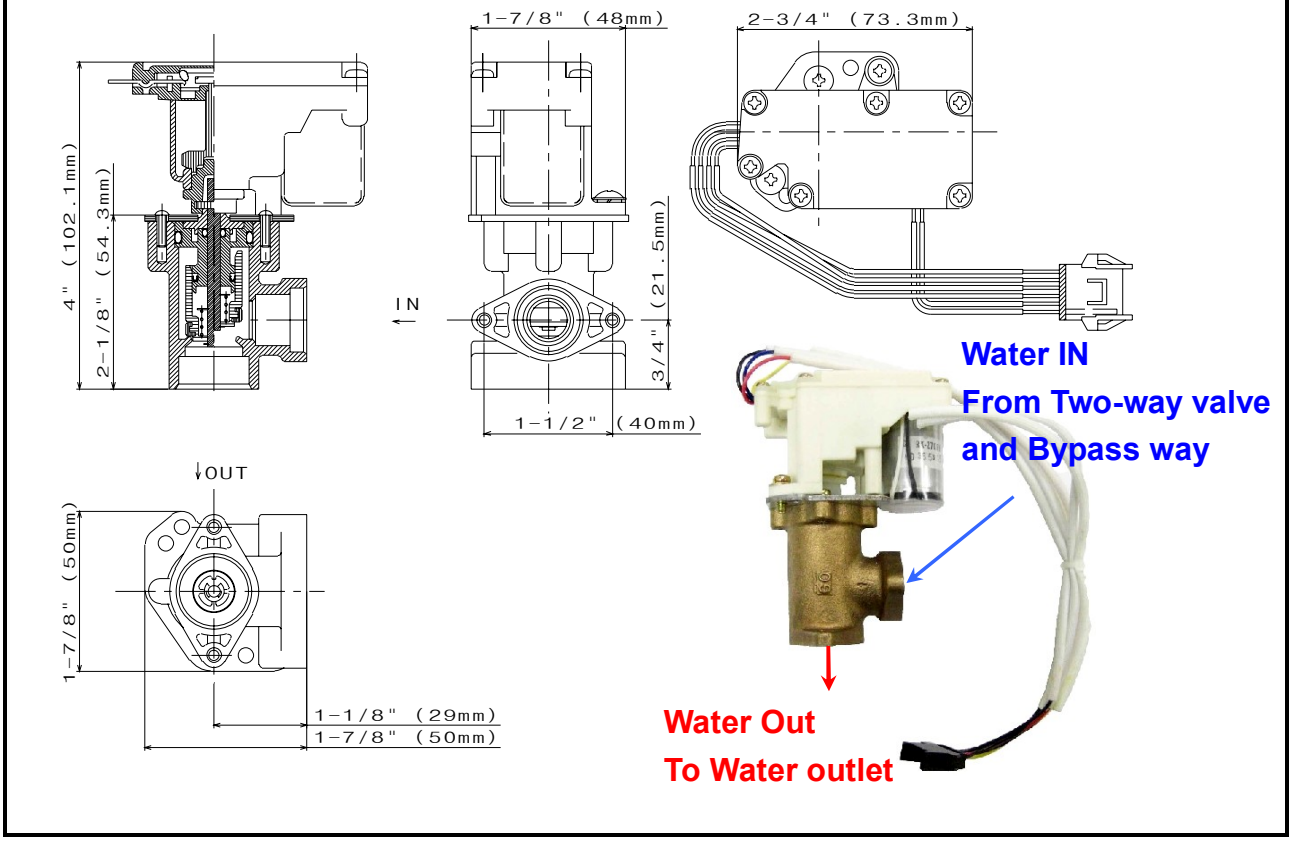
| **T-M1 or T-M199 Part #** | #015 | **Takagi Part #** | EM112 (TM1)<br>EM240 (TM199) | **Checkpoint** | **N/A** |
|---|---|---|---|---|---|
| Function | Absorb heat from combustion and transfer it to water through the heat exchanger pipes. | | | | |
| Failure events | 1. Clogged heat exchanger fins and/or cracks on the heat exchanger walls.<br>2. Leaking exhaust gas.<br>3. Improper heat transfer can cause the water in heat exchanger to boil.<br>4. Calcium deposits inside the pipe. | | | | |
| Effects on the Water heater if the heat exchanger fails | 1. Water leakage from the heat exchanger<br>2. Exhaust gas leakage (if this occurs, an overheat cutoff fuse is in place to detect this event and immediately stop the Water heater from operating)<br>3. Abnormal sounds during combustion<br>4. Hi-limit switch trips or water leaks from the pipe | | | | |
| Error codes when the heat exchanger fails | **N/A** | | | | |
| Diagnostic | 1. Visual inspection: soot deposits, cracks on the heat exchanger walls, and/or water leakage from the heat exchanger.<br>2. In the event of abnormal sounds during combustion:<br>A. Inspect for soot buildup inside the heat exchanger.<br>B. Inspect for scale buildup inside the heat exchanger pipes. Scale buildup obstructs proper heat transfer to the water, thereby overheating the heat exchanger and causing damage. | | | | |
| Color/Number of wires | **N/A** | | | | |




NOTE: The material of the exhaust chamber of the T-M199 is different from that of the T-M1
(T-M1: Galvanized Steel / T-M199: Stainless-steel)

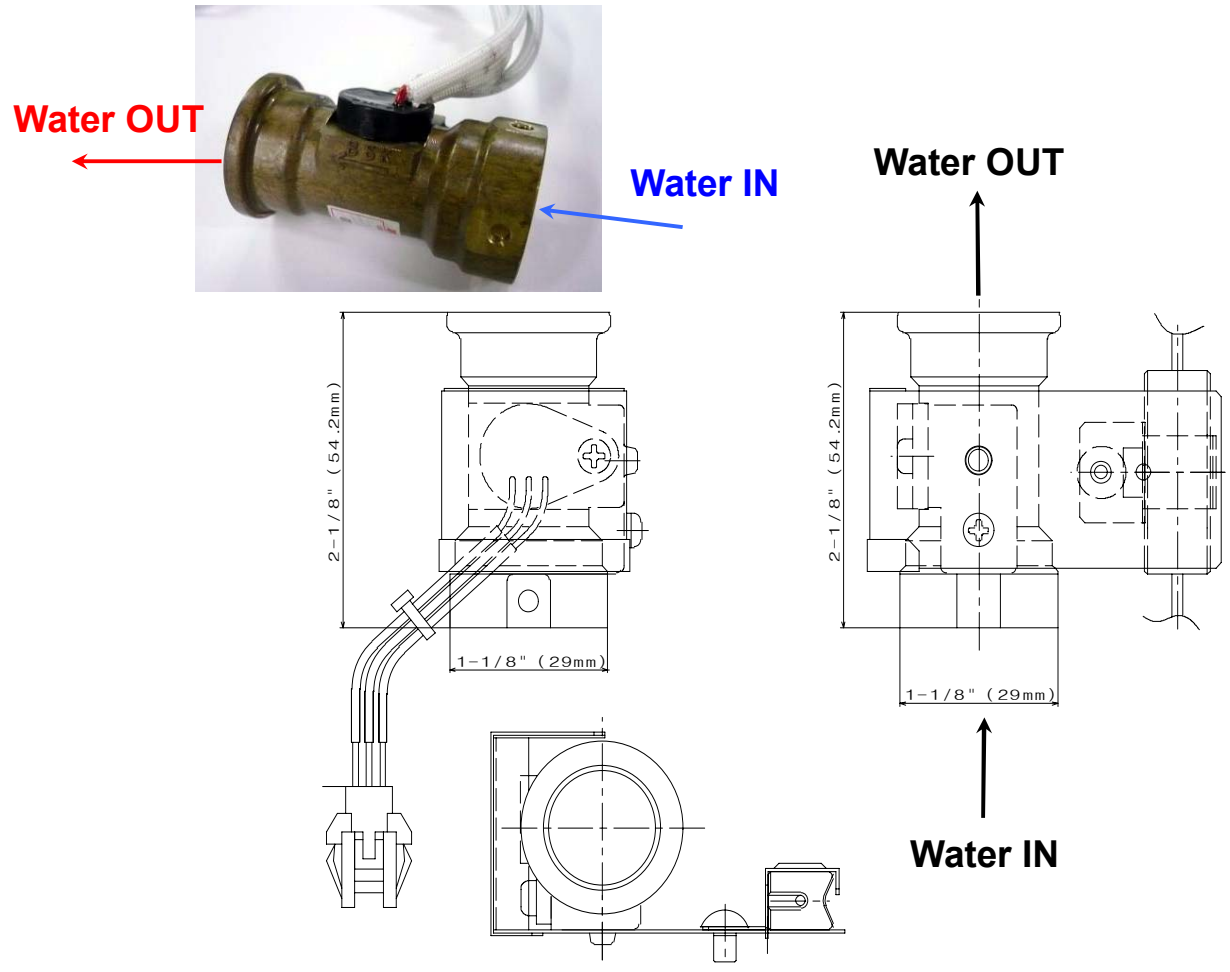
## 10-7. Flow adjustment valve

| T-M1 or T-M199 Part # | #037 | Takagi Part # | EM120 | Checkpoint | J1 |
|---|---|---|---|---|---|
| Function | 1. Controls water flow to properly control the output hot water temperature.<br>2. Adjusts water flow of the system during multi-unit system operation. | | | | |
| Failure events | 1. Water leakage from valve.<br>2. The valve cannot modulate or make open/close positions.<br>3. Unable to control water flow in a multi-unit system. | | | | |
| Effects on the Water heater if flow adjustment valve fails | 1. Water leakage from failed valve can damage other Water heater components.<br>2. Temperature fluctuations in the hot water output. | | | | |
| Error codes when flow adjustment valve fails | **651** | | | | |
| Diagnostic | 1. Visual inspection: connection/breakage of wires, motor drive locked due to scale buildup, and/or water leakage.<br>2. Check voltages and resistance; proper range of values shown below. | | | | |
| Color/Number of wires | White - Black DC 13.0～16.0V | | | | |
| | White - Black 15～30kΩ | | | | |
| | Yellow - Black Less than DC1V | | | | |



## 10-8. Flow sensor

| T-M1 or T-M199 Part # | #059 | Takagi Part # | EM143 | Checkpoint | H2 |
|---|---|---|---|---|---|
| Function | Detects and measures water flow rate using a spinning impeller and magnetic pick-up. | | | | |
| Failure events | Unable to detect or measure any water flow rate. | | | | |
| Effects on the Water heater if flow sensor fails | Ignition sequence does not start (Water heater will not initiate any operation) | | | | |
| Error codes when flow sensor fails | **441 (only within Multi-unit systems)** | | | | |
| Diagnostic | 1. Visual inspection: connection/breakage of wires and/or debris on impeller.<br>2. Check voltages: proper range of values shown below. | | | | |
| Color/Number of wires | Red - Black | DC4.0～5.5V (Input) | | | |
| | White(+) –Black(GND) | DC1.0～4.0V (pulse)<br>1,200 pulse/min (more than 20Hz) | | | |

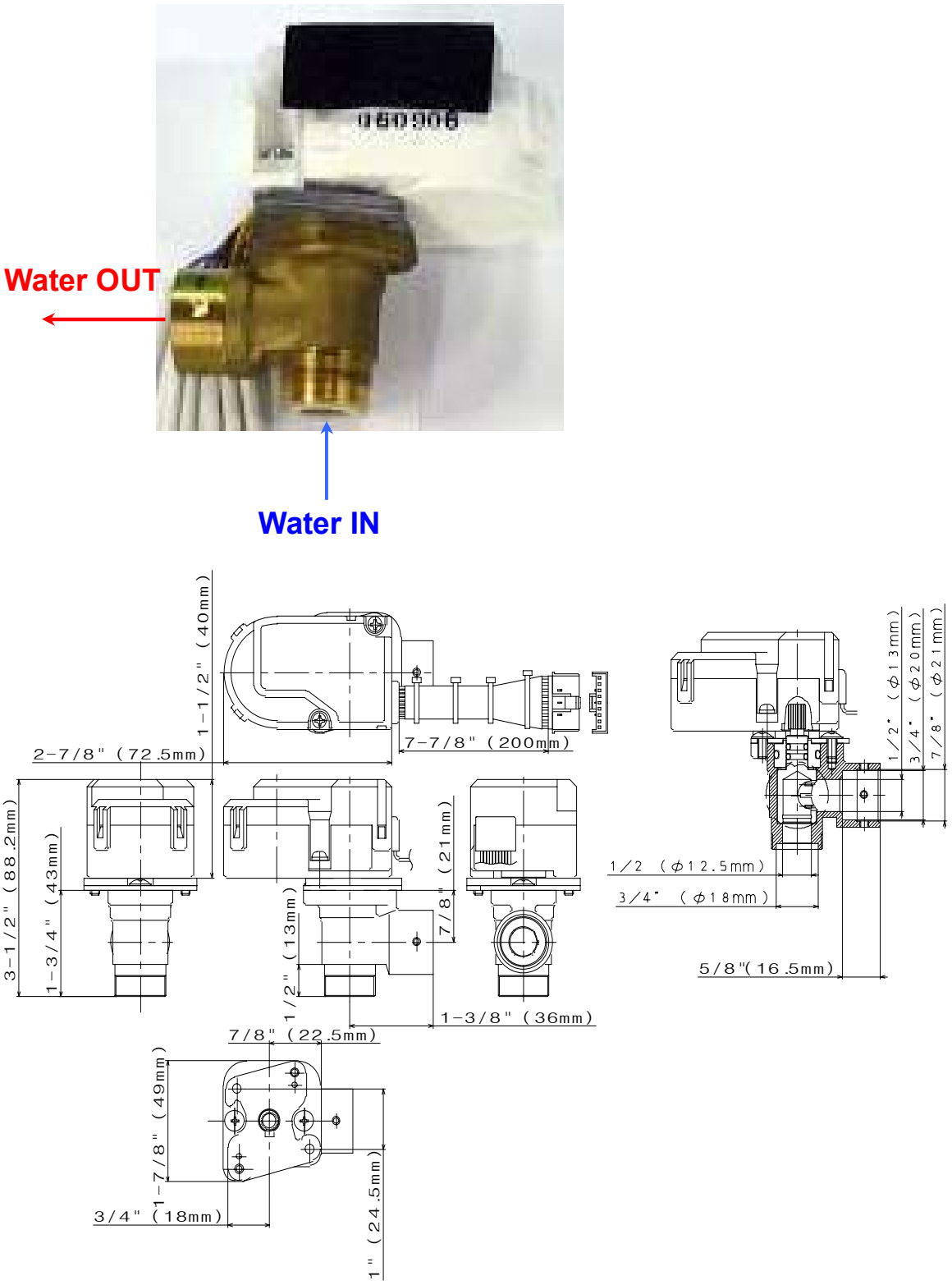


## 10-9. Bypass valve

| T-M1 or T-M199 Part # | #051 | Takagi Part # | EM116 | Checkpoint | J2 |
|---|---|---|---|---|---|
| Function | 1. Mixes hot water from the heat exchanger with cold water from the water inlet in order to modulate and control the Water heater's outlet water temperature. 2. Keeps the water temperature in the heat exchanger stable, preventing low-temperature corrosion caused by heat exchanger condensation.<br>See these following conditions:<br>When the temperature setting is 149˚F (65˚C) or over, the bypass valve closes completely, so all flow will go through to the heat exchanger.<br>When the temperature setting is 140˚F (60˚C) or below, the bypass valve will keep the water temperature of the heat exchanger between 149˚F (65˚C) and 167˚F (75˚C). | | | | |
| Failure event | 1. Water leakage from valve.<br>2. The valve cannot modulate or make open/close positions. | | | | |
| Effects on the Water heater if bypass valve fails | 1. Water leakage from failed valve can damage other Water heater components.<br>2. Temperature fluctuations in the hot water output. | | | | |
| Error codes when bypass valve fails | **661** | | | | |
| Diagnostic | 1. Visual inspection: connection/breakage of wires.<br>2. Check voltages and resistance: proper range of values shown below. | | | | |
| Color/Number of wires | White-Blue | DC12.0～14.5V | | | |
| | Blue-Black | DC1.0～14.5V | | | |
| | White-Black | 27～33Ω | | | |
| | Blue-Orange | DC1.0～14.5V | | | |
| | White-Orange | 27～33Ω | | | |
| | Blue-Green | DC1.0～14.5V | | | |
| | White-Green | 27～33Ω | | | |
| | Blue-Purple | DC1.0～14.5V | | | |
| | White-Purple | 27～33Ω | | | |
| | Red-Blue | DC12.0～14.5V | | | |
| | Brown-Blue | Less than DC1V | (Opened position) | | |
| | Yellow-Blue | DC4.5～5.5V | | | |

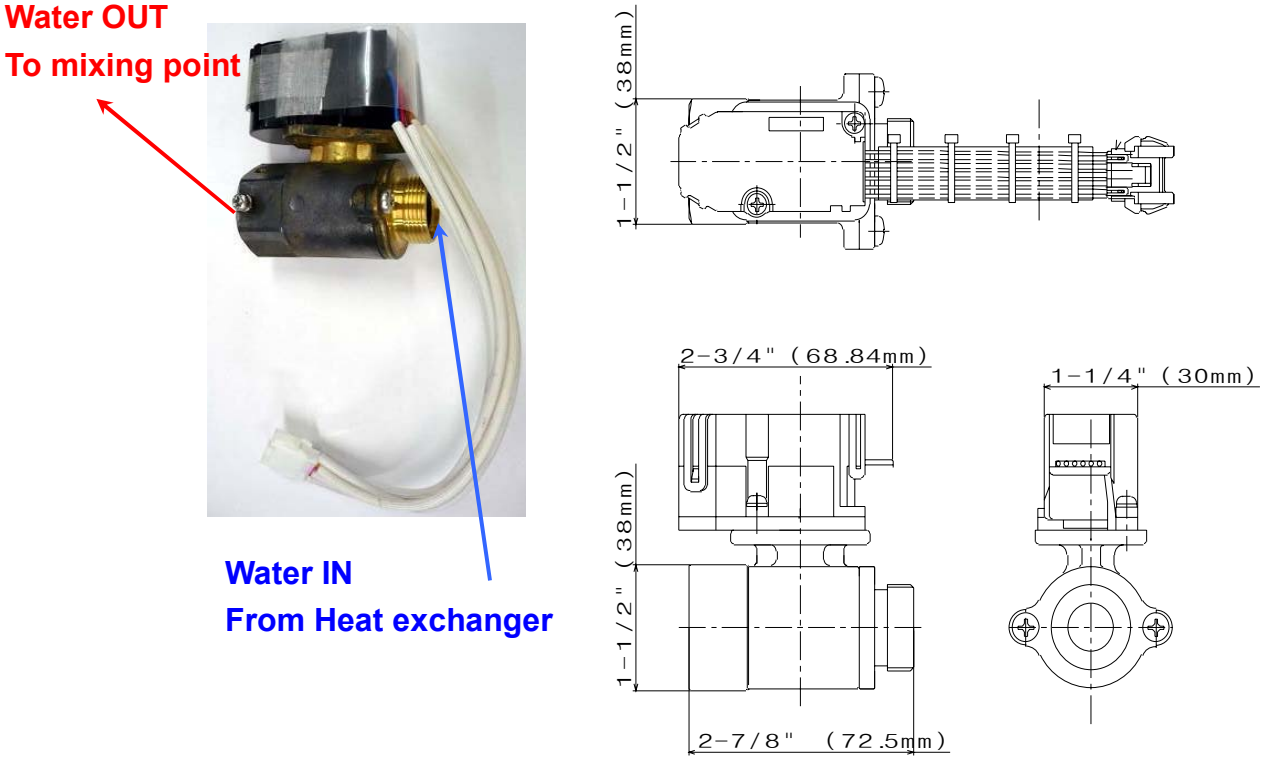
**NOTE: Pictures are on the following page.**

## 10-9. Bypass valve



## 10-10. Two way valve

| T-M1 or T-M199 Part # | #030 | Takagi Part # | EM118 | Checkpoint | J3 |
|---|---|---|---|---|---|
| Function | The two-way valve controls the water flow from the heat exchanger in order to prevent low temperature corrosion caused by heat exchanger condensation when operation has stopped. | | | | |
| Failure events | 1. Water leakage from valve.<br>2. The valve cannot modulate or make open/close positions. | | | | |
| Effects on the Water heater if two way valve fails | 1. Water leakage from failed valve can damage other Water heater components.<br>2. Unable to control water flow from the heat exchanger.<br>3. "541"error code will appear before operation starts. | | | | |
| Error codes when two way valve fails | **541** | | | | |
| Diagnostic | 1. Visual inspection: connection/breakage of wires, motor drive locked due to scale buildup, and/or water leakage.<br>2. Check voltages and resistance; proper range of values shown below. | | | | |
| Color/Number of wires | Red - Blue | DC 10.0～13.0V (during burning) | | | |
| | Orange - Gray | DC 14.0～16.0V (during burning) | | | |
| | Yellow - Gray | Less than DC1V (opened position) | | | |
| | Brown - Gray | Less than DC1V (closed position) | | | |



## 10-11. Thermistors

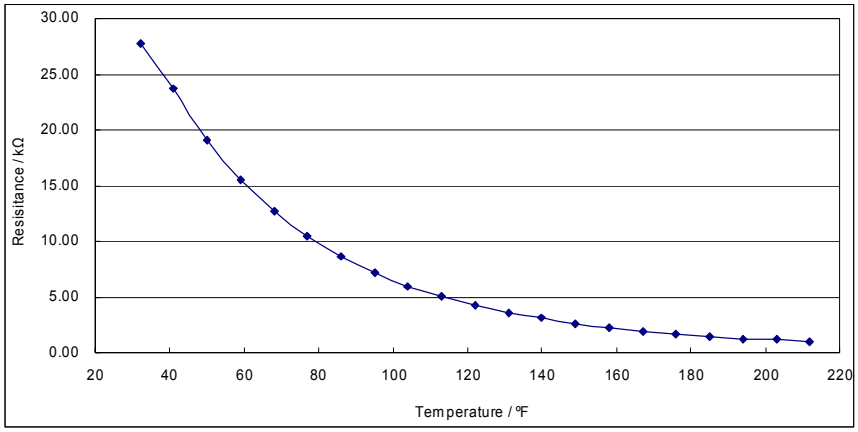
| **T-M1 or T-M199 Part #** | #027 (Inlet)<br>#019 (Output)<br>#044 (Mixing) | **Takagi Part #** | EM187 (Inlet)<br>EM186 (Output)<br>EM179 (Mixing) | **Check point** | **E1 (Mixing)**<br>**E2 (Output)**<br>**E3 (Inlet)** |
|---|---|---|---|---|---|
| Function | Measure cold/hot water temperatures in the Water heater. | | | | |
| Failure events | Unable to properly measure water temperatures within the Water heater. | | | | |
| Effects on the Water heater if thermistor fails | If the thermistors fail open or short, error code appears before starting operation. If resistance values are just off, The Water heater will have temperature fluctuations in hot water. | | | | |
| Error codes when thermistors fails | **311 (Output)** | | **321 (Inlet)** | | **331 (Mixing)** |
| Diagnostic | 1. Visual inspection: connection/breakage of wires and/or debris on thermistor.<br>2. Check voltages and resistance; proper range of values shown below. | | | | |
| Color/Number of wires | Inlet White(42)-White | | 68˚F (20°C) 12.7KΩ | | |
| | Output White(12)-White | | 122˚F (50°C) 4.27KΩ | | |
| | Mixing White(113)-White | | 176˚F (80°C) 1.69KΩ<br>(see table below for more resistance values) | | |

(Inlet thermistor) 42

(Output thermistor) 12

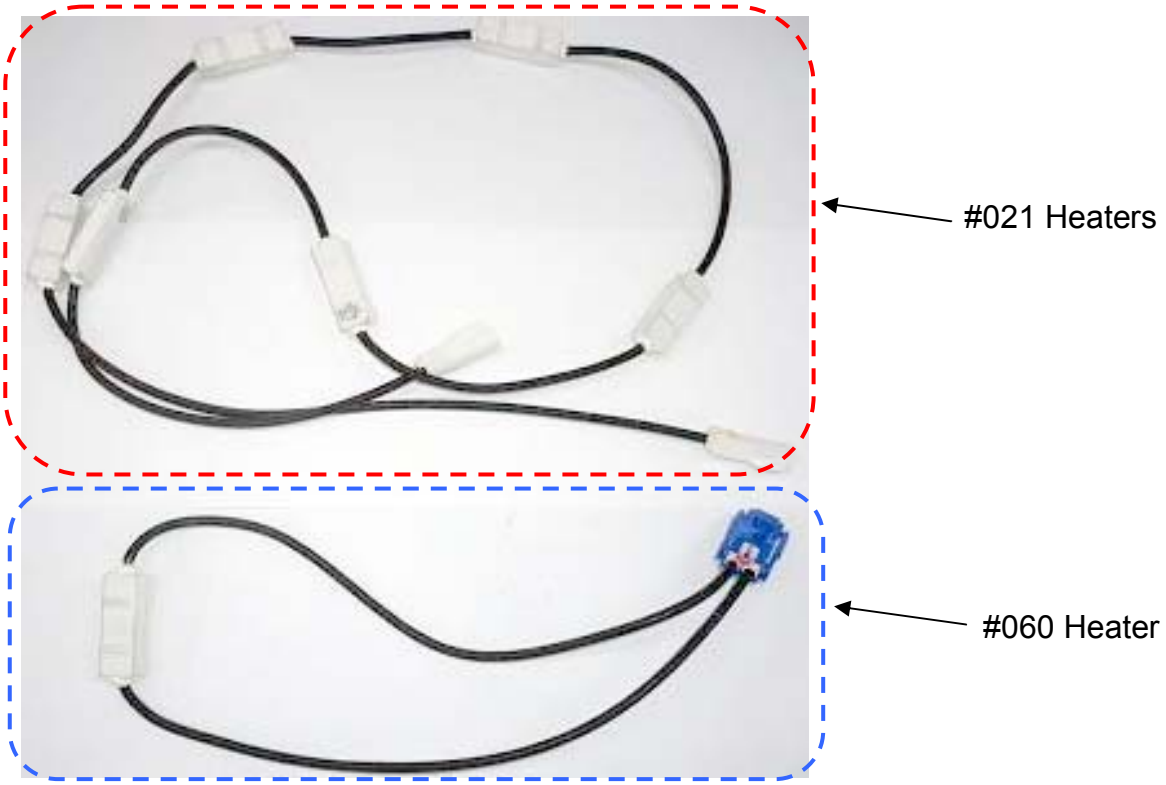
(Mixing thermistor) 113

**Resistance values of thermistors as a function of temperature**



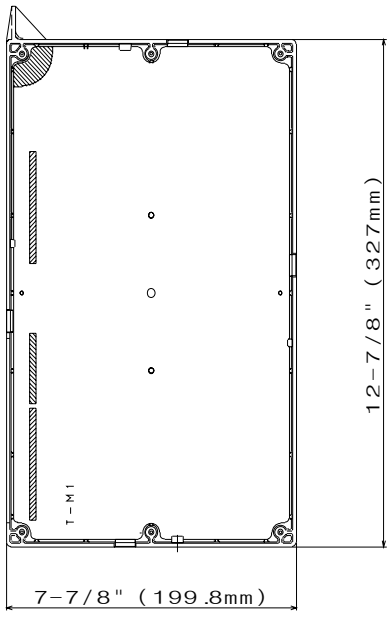
## 10-12. Freeze protection heaters

| T-M1 or T-M199 Part # | #021<br>#060 | Takagi Part # | EM166<br>EM165 | Checkpoint | B1 |
|---|---|---|---|---|---|
| Function | Prevents the heat exchanger, water valves, and water pipes within the Water heater from freezing. The heaters are but one of the freeze protection devices in the Water heater. | | | | |
| Failure events | Open circuit failure: Ceramic heaters do not receive the voltage needed to heat up. | | | | |
| Effects on the Water heater if heater fails | Ceramic heaters do not activate, allowing water contained in the heat exchanger to freeze up, possibly causing the heat exchanger to burst. | | | | |
| Error codes when heaters fails | **N/A** | | | | |
| Diagnostic | 1. Visual inspection: connection/breakage of wires and the condition of the heaters.<br>2. Check: whether those are in the normal range as shown in the following table. | | | | |
| Color/Number of wires | Black - White AC90～110V (during freeze protection operation) | | | | |



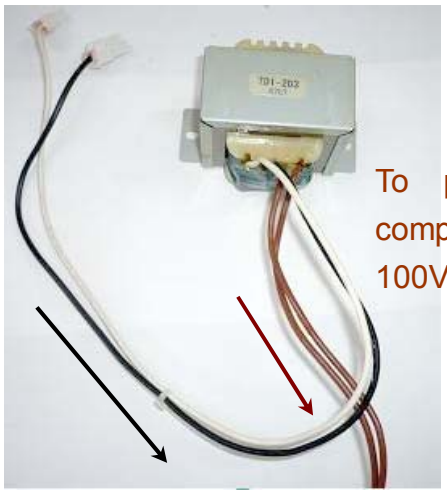
## 10-13. Computer board

| **T-M1 or T-M199 Part #** | #111 | **Takagi Part #** | EM129 (T-M1)<br>EM235 (T-M199) | **Checkpoint** | **N/A** |
|---|---|---|---|---|---|
| Function | Controls the functions of most of the parts in the Water heater. | | | | |
| Failure events | Malfunctioning computer | | | | |
| Effects on the Water heater if the computer board fails | When the computer board failed, the control from the computer board and/or to the Multi-system control will be abnormal.<br>The following are the typical examples of when the computer fail:<br><br>1. Unable to control proper combustion during operation.<br>2. Unable to detect correct signals from any/all Water heater sensors.<br>3. Unable to control water valves, which may cause output temperature fluctuations.<br>4. Errors in its self-diagnostics. In order to self-diagnose properly, the computer sends a low voltage signal into its circuit. When the computer does not detect a return signal, from this circuit, the "701" error code will appear.<br>5. Unable to communicate other Water heater's and/or the TM-MC01 (or TM-RE20) during the multi-unit system operations. | | | | |
| Error codes when the computer board fails | **701** | **721** | **741** | **761** | |
| Diagnostic | Visual inspection: connection/breakage of wires and/or burn marks on the computer board. | | | | |
| Color/Number of wires | **N/A** | | | | |



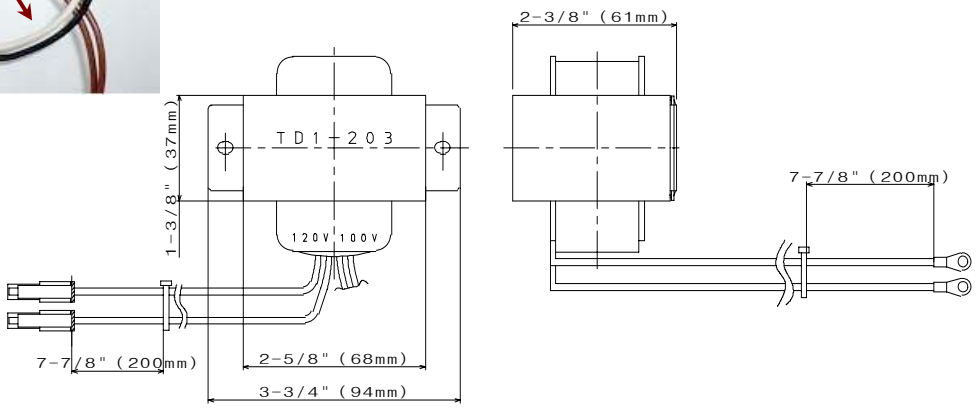
## 10-14. Transformer

| T-M1 or T-M199 Part # | #006 | Takagi Part # | EM163 | Checkpoint | A1,A2 |
|---|---|---|---|---|---|
| Function | -To transform input voltage from 120VAC to 100VAC.<br>-Every electrical component of the Water heater is designed to only work with a 100VAC power supply, therefore, the Water heater comes equipped with this transformer. | | | | |
| Failure events | 1. There is no power coming from the transformer.<br>2. The voltage from the power supply cannot be converted to 100VAC. | | | | |
| Effects on the Water heater if transformer fails | 1. The Water heater does not operate due to lack of power from transformer.<br>2. A failed transformer can cause electrical damage to other electrical components within the Water heater. | | | | |
| Error codes when transformer fails | **N/A** | | | | |
| Diagnostic | 1. Visual inspection: connection/breakage of wires and/or signs of electrical damage.<br>2. Check voltages of the transformer: Proper range of values shown below. | | | | |
| Color/Number of wires | White – Black AC108～132V<br>Brown – Brown AC90～110V | | | | |



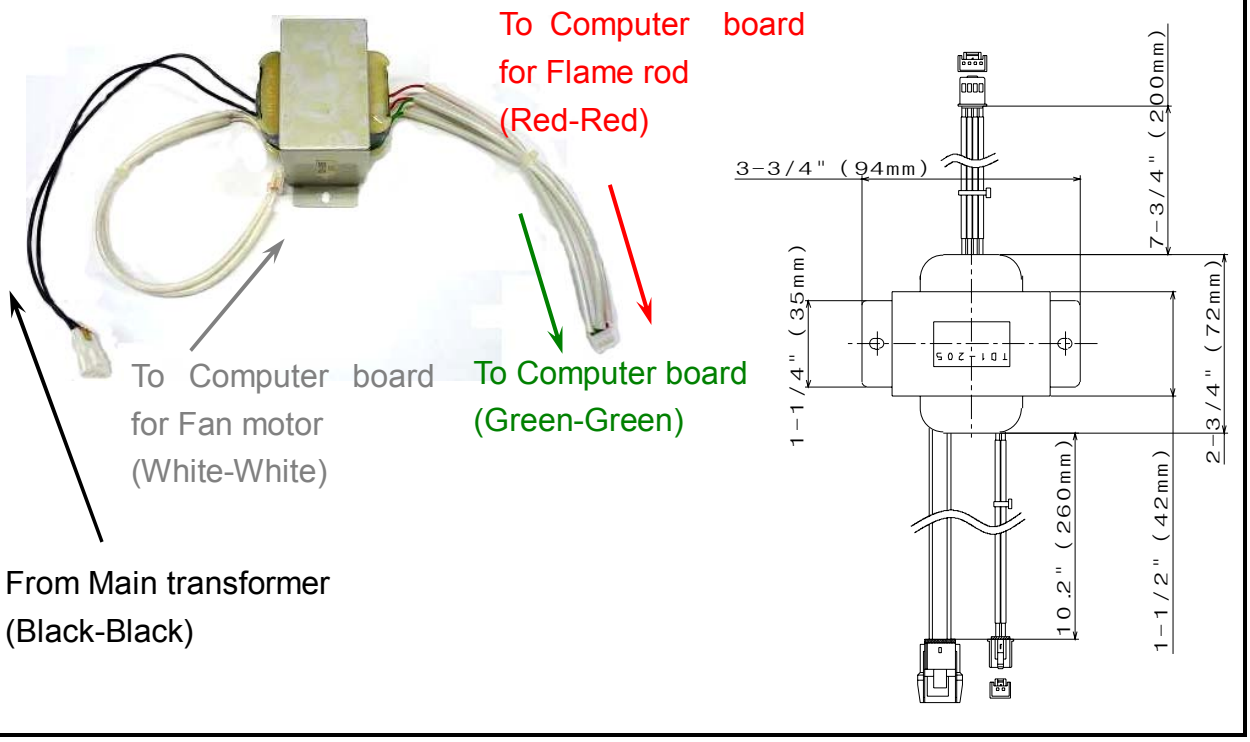
To power the computer board 100VAC

From the 120 VAC power supply



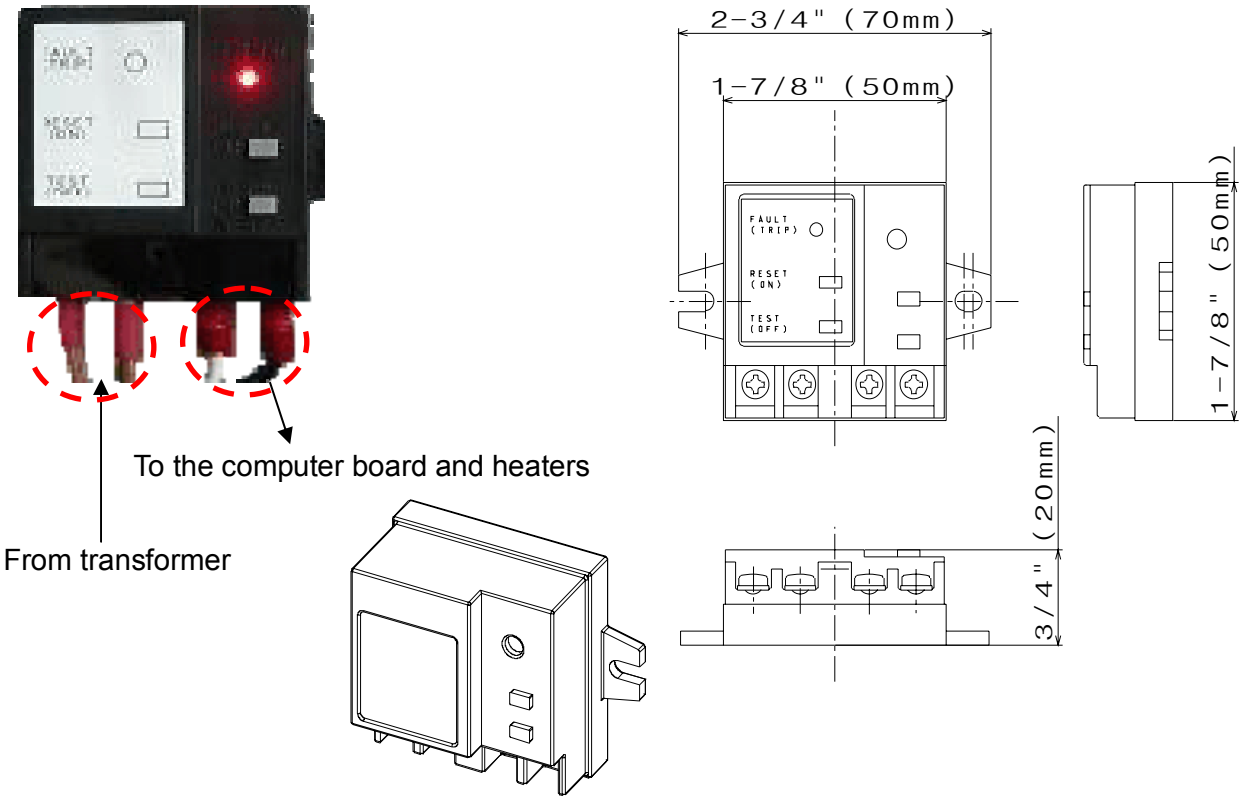
## 10-15. Computer transformer

| T-M1 or T-M199 Part # | #005 | Takagi Part # | EM164 | Checkpoint | A3,A4,A5 |
|---|---|---|---|---|---|
| Function | To transform voltage from 100V to the following:<br>AC 15V to the Fan motor.<br>AC 20V for control source in the computer board.<br>AC 55V to the flame rod. | | | | |
| Failure events | 1. There is no power coming from the computer transformer.<br>2. The voltage from power supply can not be converted. | | | | |
| Effects on the Water heater if transformer fails | 1. The Water heater does not operate due to lack of power from computer transformer.<br>2. A failed transformer can cause electrical damage to other electrical components within the Water heater. | | | | |
| Error codes when transformer fails | **N/A** | | | | |
| Diagnostic | 1. Visual inspection: connection/breakage of wires and/or signs of electrical damage.<br>2. Check voltages of the transformer: Proper range of values shown below. | | | | |
| Color/Number of wires | White – White | AC10～15V / 10～20Ω | | | |
| | Green – Green | AC15～25V / 0.4～0.8Ω | | | |
| | Red – Red | AC45～65V / 42～62Ω | | | |



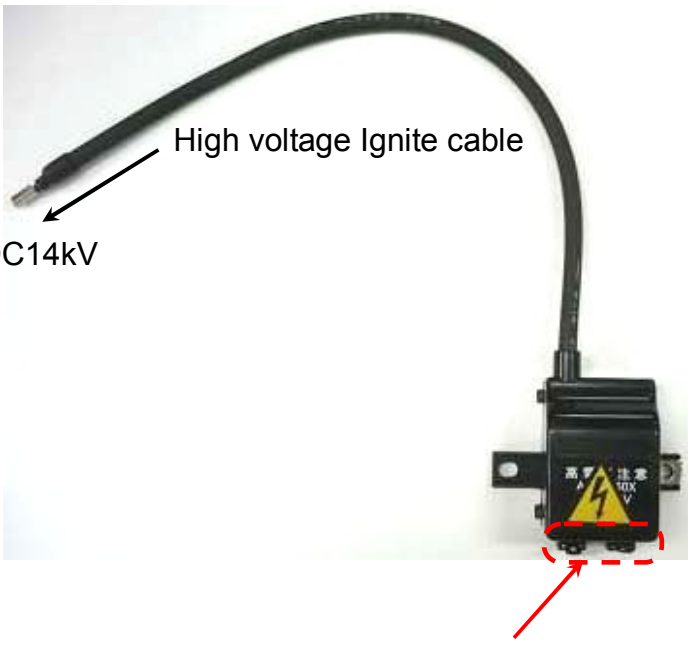
## 10-16. GFI

| T-M1 or T-M199 Part # | #123 | Takagi Part # | EM207 | Checkpoint | A,A1 |
|---|---|---|---|---|---|
| Function | -Detects electrical leakage in the Water heater<br>-Stops providing power to the Water heater in the case of electrical leakage. | | | | |
| Failure event | 1. ON-failure: Always in the ON mode (never trips).<br>2. OFF-failure: Always in the OFF mode (always stays tripped). | | | | |
| Effects on the Water heater if the GFI fails | 1. ON-failure: GFI cannot detect electrical leakage within the Water heater.<br>2. OFF-failure: the Water heater does not receive any power from the GFI, which means the Water heater cannot operate. | | | | |
| Error codes when the GFI fails | **N/A** | | | | |
| Diagnostic | 1. Visual inspection: connection/breakage of wires and/or some signs of electrical damage on the GFI.<br>2. Check the power supply to the GFI. If the red LED on the GFI lights up after pressing the "test" button, the GFI is receiving power. After verifying the power supply, verify that 100VAC is entering and leaving the GFI. | | | | |
| Color/Number of wires | **N/A** | | | | |

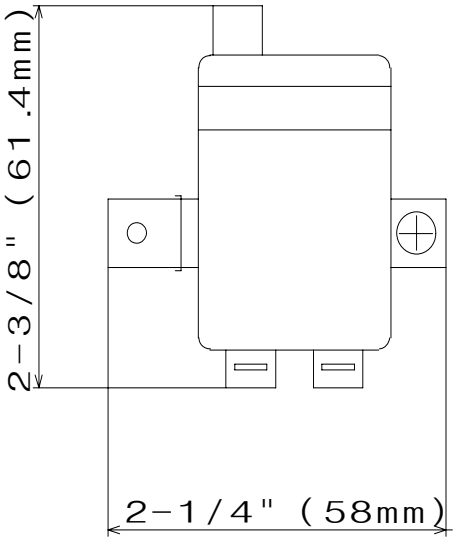


## 10-17. Igniter

| T-M1 or T-M199 Part # | #099 | Takagi Part # | EM208 | Checkpoint | B |
|---|---|---|---|---|---|
| Function | -To ignite the gas/air mixtures when the Water heater is ready to burn gas on its burner surface.<br>-The output voltage of the igniter is more than 14kV. | | | | |
| Failure events | 1. Unable to ignite during the ignition process.<br>2. Makes attempts to ignite at all times. | | | | |
| Effects on the Water heater if the igniter fails | 1. The Water heater cannot ignite during the ignition process and the "111" or "121" error codes will display.<br>2. No effects on the Water heater, however, the durability of the igniter wears down. | | | | |
| Error codes when Igniter fails | **111** | | | **121** | |
| Diagnostic | 1. Visual inspection: connection/breakage of wires and/or an observed weak spark.<br>2. Check voltages: proper range of values shown below. | | | | |
| Color/Number of wires | Purple - Purple 90 VAC-110 VAC | | | | |




NOTE: The high-voltage igniter cable and the purple wires do not come with EM208.

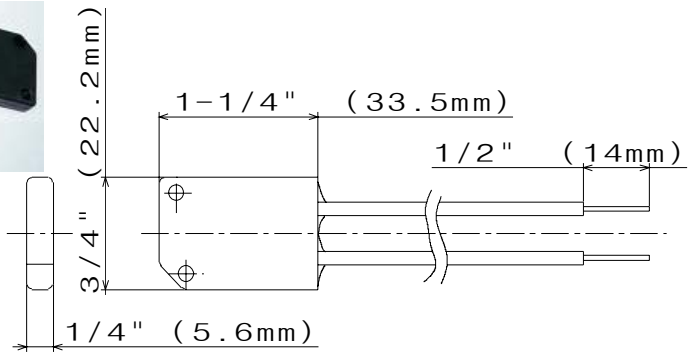


## 10-18. Freeze protection thermostat

| T-M1 or T-M199 Part # | #090 | Takagi Part # | EM142 | Checkpoint | B1 |
|---|---|---|---|---|---|
| Function | Temperature detecting device which prevents the pipes within the Water heater from freezing. When this device detects temperatures below 36.5˚F (2.5˚C) inside the Water heater, power is supplied to the electric heaters to prevent the Water heater from freezing. | | | | |
| Failure events | 1. ON-failure (Always senses freezing temperatures, regardless of actual temperature).<br>2. OFF-failure (Never senses freezing temperatures). | | | | |
| Effects on the Water heater if the freeze protection thermostat fails | 1. The freeze protection heaters will always be ON, causing heat damage to components inside the Water heater.<br>2. The freeze protection heaters will never be able to turn on, even under freezing temperatures, causing freeze damage to the Water heater. | | | | |
| Error codes when the freeze protection thermostat fails | **N/A** | | | | |
| Diagnostic | 1. Visual inspection: connection/breakage of wires and/or the body has been broken.<br>2. Check resistance and voltage: proper range of values shown below. | | | | |
| Color/Number of wires | Black - Black (itself) | ON mode: 90 VAC - 110 VAC and less than 1Ω<br>OFF mode: less than 1 VAC and more than 1MΩ | | | |

**Activation and deactivation temperature of the T-M1's or T-M199's freeze protection system**

| | |
|---|---|
| ON mode: 36.5˚F(+6.3˚F -2.7˚F) | 2.5˚C(+3.5˚C -1.0˚C) |
| OFF mode: above 46.4˚F | above 8 ˚C |

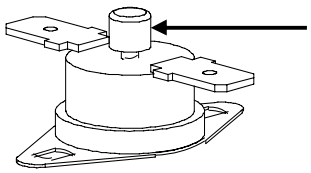


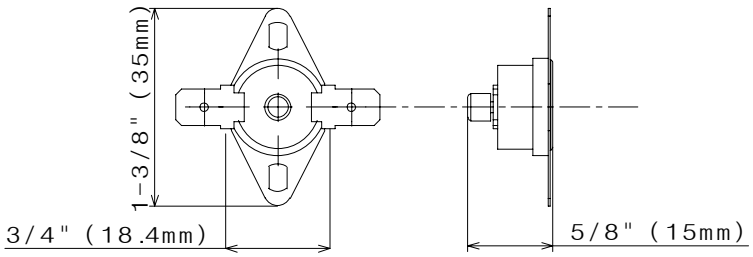
## 10-19. Hi-limit switch

| T-M1 or T-M199 Part # | #016 | Takagi Part # | EM212 | Checkpoint | C1 |
|---|---|---|---|---|---|
| Function | -Based on bi-metal thermal expansion.<br>-Detects excessively high water temperature (more than 185˚F or 85˚C) in pipes of the heat exchanger. | | | | |
| Failure events | 1. Unable to detect excessively high water temperatures if switch fails "closed".<br>2. Continuous detection of excessively high water temperatures (regardless of what the actual water temperature is) if switch fails "open". | | | | |
| Effects on the Water heater if hi-limit switch fails | 1. Unable to shut down the Water heater if the water temperature from the heat exchanger exceeds 185˚F (85˚C).<br>Note: The mixing and outlet thermistors always act as backup hi-limit detectors to detect excessively high water temperatures in the heat exchanger.<br>2. The Water heater is always shut down immediately after the pre-check, and the "141" error code will display. | | | | |
| Error codes when hi-limit switch fails | **141** | | | | |
| Diagnostic | 1. Visual inspection: connection/breakage of wires. Possibility also includes scale deposits inside the heat exchanger.<br>2. Check voltages and resistance: proper range of values shown below. | | | | |
| Color/Number of wires | Red-Red DC Less than 1.0Ω | | | | |

**When temperatures exceed 185˚F (85˚C), the reset button trips and switch goes to OFF mode.**

ON mode : <185˚F (85˚C) OFF mode: to reset switch back to ON mode, press the reset button

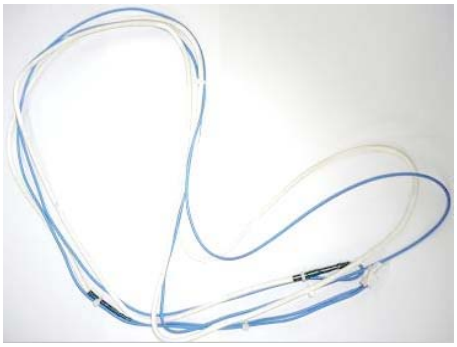


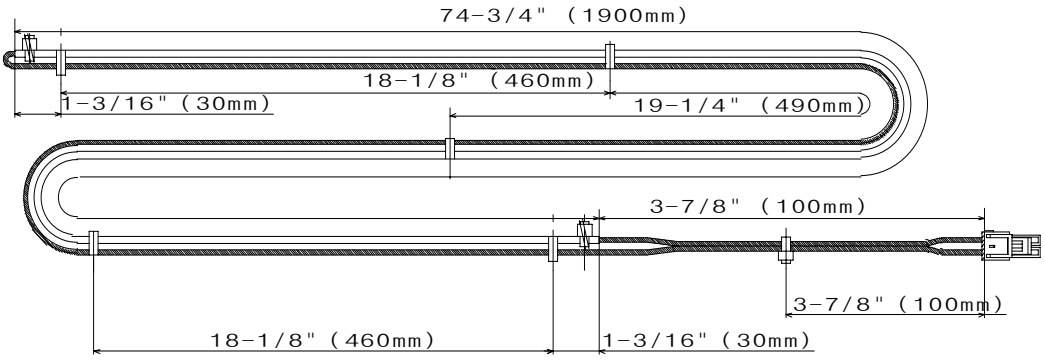



## 10-20. Overheat cutoff fuse

| T-M1 or T-M199 Part # | #025 | Takagi Part # | EM138 | Checkpoint | C2 |
|---|---|---|---|---|---|
| Function | -The overheat cutoff fuse contains solder with a melting point of 365˚F (185˚C).<br>-Detects excessive temperatures within the Water heater, especially around the heat exchanger and combustion chamber. Upon detection, communication between the computer board and gas valves will sever, shutting down the Water heater instantly. The "111" or "121" error code will display. | | | | |
| Failure events | 1. Unable to detect the excessively high temperatures within the Water heater. | | | | |
| Effects on the Water heater if the overheat cutoff fuse fails | 1. Flames from burner may penetrate a ruptured/damaged heat exchanger.<br>2. Gas valves will not operate. | | | | |
| Error codes when the overheat cutoff fuse fails | **111** | | **121** | | |
| Diagnostic | 1. Visual inspection: connection/breakage of wires.<br>2. Check voltages and resistance: proper range of values shown below. | | | | |
| Color/Number of wires | Blue-Blue Less than 1.0Ω | | | | |

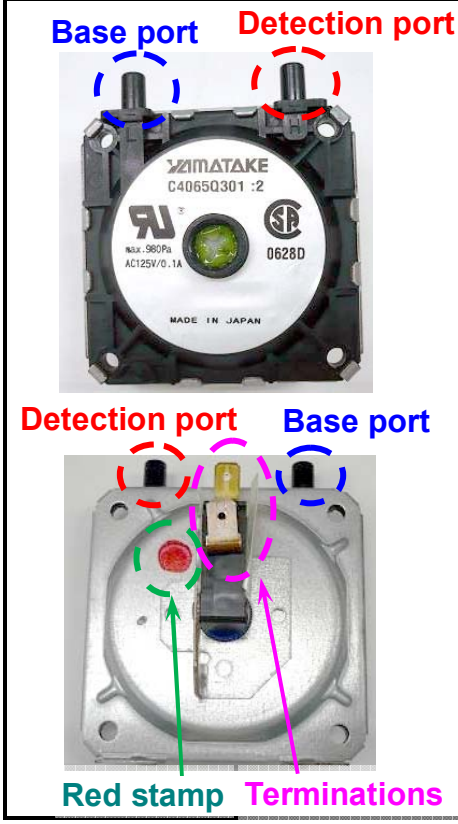
Solder will melt at temperature exceeding 365˚F(±9˚F) or 185˚C(±5˚C)

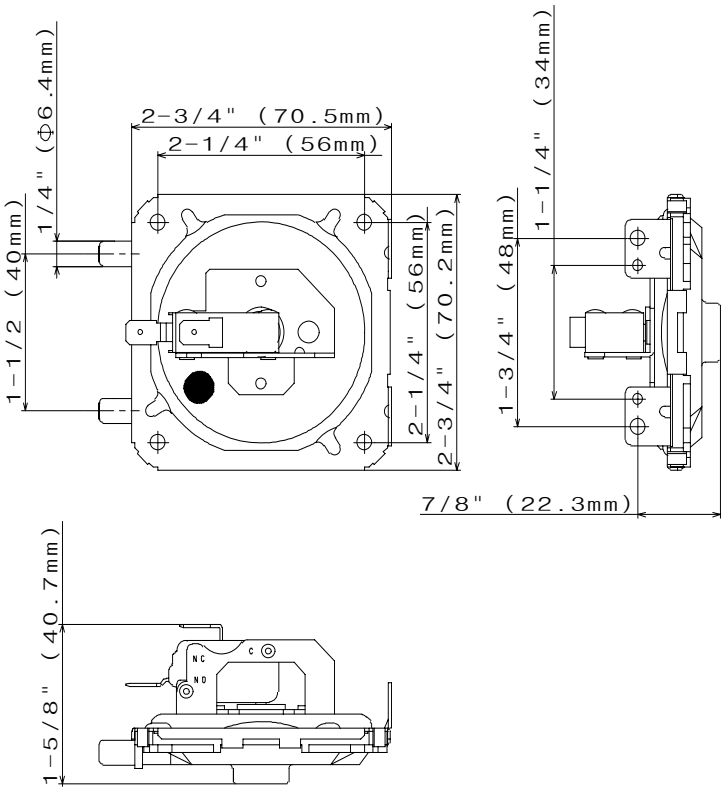




## 10-21. Pressure Switch

| T-M1 or T-M199 Part # | #086 | Takagi Part # | EKD08 | Checkpoint | P |
|---|---|---|---|---|---|
| Function | Detects the pressure in the combustion chamber of the Water heater. When there are any obstructions in the vent or if the heat exchanger is clogged with soot, the unit's exhaust will have high CO emission since the pressure in the chamber increases and makes the fan motor push the combustion air but the vent or heat exchanger is clogged. Pressure switch detects an excess pressure when the circuit in the pressure switch trips, and then the "211" error code will occur. | | | | |
| Failure events | 1. ON-failure: (Always in ON mode).<br>2. OFF-failure: (Always in OFF mode). | | | | |
| Effects on the Water heater if the pressure switch fails | 1. In the "Always the ON failure", The "211" error code will display and the operation is stopped.<br>2. In the "Always the OFF failure", The unit can work and the "211" error code is not displayed, In this case, the unit can emit the excess CO from the exhaust chamber. | | | | |
| Error codes when the pressure switch fails | **211** | | | | |
| Diagnostic | Visual inspection: connection/breakage of wires. | | | | |
| Color/Number of wires | **N/A** | | | | |

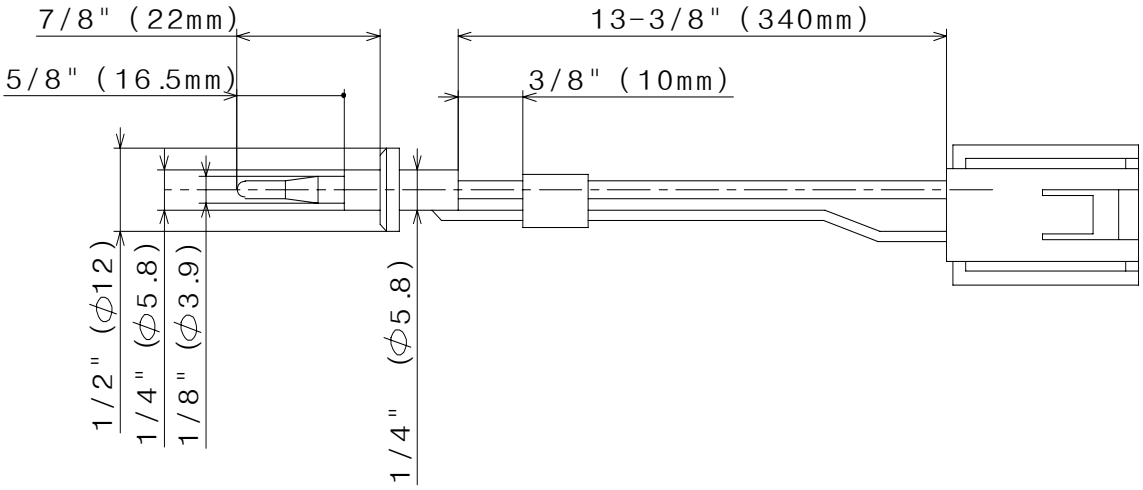


## 10-22. Thermocouple

| T-M1 or T-M199 Part # | #079 | Takagi Part # | EM202 | Checkpoint | O |
|---|---|---|---|---|---|
| Function | -Checks flame conditions during combustion.<br>-When Thermocouple detects unexpected flame conditions, the Water heater's computer makes adjustments in the fan motor speed to compensate. | | | | |
| Failure events | Unable to detect flame conditions when flame actually do occur. | | | | |
| Effects on the Water heater if the thermocouple fails | The fan motor speed cannot be modulated properly under abnormal flame conditions, which can result in excessive CO emission. | | | | |
| Error codes when Thermocouple fails | **101** | | **391** | | **991** |
| Diagnostic | 1. Visual inspection: connection/braking of wires.<br>2. Check voltages: proper range of values are shown below. | | | | |
| Color/Number of wires | Yellow-Cupper DC1mV～9mV (during combustion) | | | | |

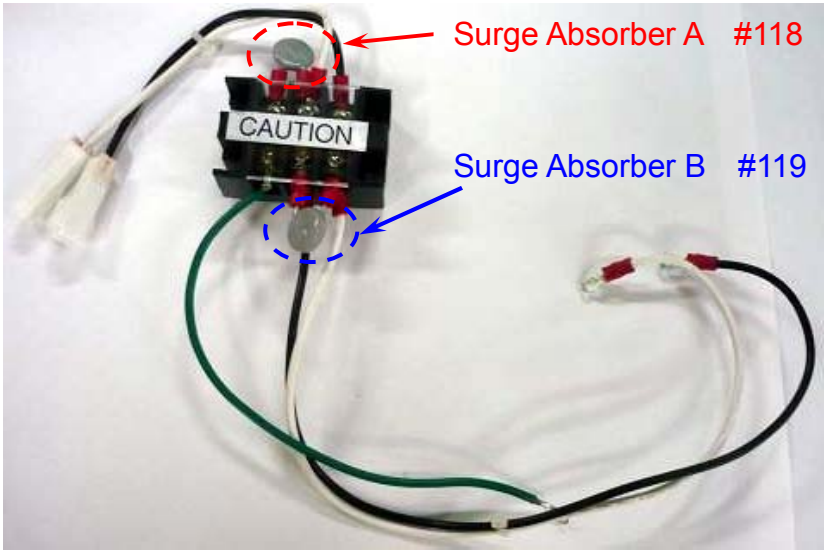
Sensing element



## 10-23. Surge absorber

| T-M1 or T-M199 Part # | #118<br>#119 | Takagi Part # | EM182<br>EM183 | Checkpoint | N/A |
|---|---|---|---|---|---|
| Function | Protects the unit from high voltage and/or high electric current caused by lightning.<br>There are 2 types of surge absorbers in the Water heater. Surge absorber A is activated by voltage higher than 680V, the other one is activated by voltage higher than 220V. | | | | |
| Failure events | 1. Open-failure of the absorber.<br>2. Short-failure of the absorber. | | | | |
| Effects on the Water heater if the fuse box fails | 1. Unable to protect the computer board if high voltage comes into the unit, the computer board can be shorted out all operations of the unit can be stopped.<br>2. The unit cannot operate because the absorber shorted out. | | | | |
| Error codes when the fuse box fails | **N/A** | | | | |
| Diagnostic | 1.Visual inspection: burn marks on components and/or connection/breakage of wires.<br>2. Check resistance and voltage: proper range of values shown below. | | | | |
| Color/Number of wires | **N/A** | | | | |

Surge absorber A #118: 680V  Surge absorber B #119: 220V



## 11. Fault Analysis & Specifications

Remarks:
1. Proper range of values of voltage & resistance shown below.
2. Please refer to the wiring diagram for checkpoint positions.
3. Remove power to the Water heater when checking for continuity, disconnections, resistance values, etc.

| Natural of Fault | Diagnosis | Check point |
|---|---|---|
| ・No display on temperature remote controller, even when remote is turned on. | 1 Check the power supply<br>[1] Check the power supply from the GFI to the PCB<br>**(Refer to section12-3)**<br>[2] Check the power supply line to the Water heater | |
| | 2 Fault of GFI<br>Normal: AC100V between (white-black)<br>Normal: AC100V between (brown-brown) | <br>A<br>A1 |
| | 3 Fault of transformer<br>[1] Disconnection / breakage of wires<br>Normal: AC120V between (white-black)<br>Normal: AC100V between (brown-brown) | <br><br>A2<br>A1 |
| | 4 Blown fuse at PCB (5A) | A2 |
| | 5 Fault of computer transformer<br>Normal: AC15V between white-white (fan motor)<br>Normal: AC20V between green-green<br>(Power source for computer board)<br>Normal: AC55V between red-red (flame rod) | <br>A3<br>A4<br><br>A5 |
| | 6 Fault of PCB<br>[1] No voltage at remote control terminal<br>Normal: 14V DC～16V DC between (black-white) | <br>F |
| | 7 Disconnection/short-circuit/grounding of remote wires<br>Normal: 14V DC～16V DC between (black-white) | |
| | 8 Fault of PCB of remote control<br>[1] Check for normal voltage at terminal | |
| ・It takes long time to get hot water at the fixtures | 1 The time it takes to deliver hot water from the Water heater to your fixtures depend on the length of piping between them. The longer the distance and/or the bigger the pipes, the longer it will take to get hot water. | |
| ・The water is not hot enough | 1 Check cross pluming between cold water lines and hot water lines.<br>2 Check whether the gas supply pressure is enough.<br>3 Check whether the temperature setting is too low. | |
| ・The hot water turns cold and stays cold | 1 Check whether the flow rate enough to keep the Water heater running.<br>2 Check if there is a recirculation system installed and check also if the recirculation line has enough check valves.<br>3 Check that the filter on the cold water inlet is clean.<br>4 Check that the fixtures are free from debris and obstructions. | |

| Natural of Fault | Diagnosis | Checkpoint |
|---|---|---|
| · The water is too hot | 1 Check whether the temperature setting is too high. | |
| · The hot water is not available when a fixture is opened | 1 Make sure the unit gets a 120V 60Hz power supply.<br>2 If the remote controller is used, check whether the power button is turned on.<br>3 Check that the filter on the cold water inlet is clean.<br>4 Check whether the hot water fixture is sufficiently open to draw at least 0.75 GM through the water heater.<br>5 Check that the filter on the cold water inlet is clean.<br>6 Check whether or not the unit is frozen.<br>7 Check if there is enough gas in the tank. (for propane units) | |
| · The fan motor is still spinning after operation has stopped | 1 This is normal operation. After operation has stopped, the fan motor keeps its running for 35 seconds in order to re-ignite quickly, as well as purge all the exhaust gas out of the flue. | |
| · Abnormal sounds come from the unit | 1 Check the gas type of the Water heater.<br>2 Check how long the Water heater has been installed and in use.<br>3 Check the installation place.<br>4 Check the altitude/elevation of area of where the Water heater installed.<br>5 Check the vent length, when the Water heater has been installed indoors.<br>6 Check the type of vent cap, when the Water heater has been installed outdoors.<br>7 Check if there is any blockage in the intake air and/or exhaust.<br>8 Check if there is dust and lint in burner and heat exchanger, when the water heater has been installed in laundry room.<br>9 Check if there is grease and dirt in burner and fan motor, when the water heater has been installed in restaurant.<br>10 Check the manifold pressure in the Water heater. | |

| Natural of Fault | Malfunction description | Cancellation method |
|---|---|---|
| ・Fluctuation of hot water temperature | -Fault of gas solenoid valves ($SV_1$ & $SV_3$) during change of the combustion stage<br><br>-Fault of flow adjustment valve | |

| Diagnosis | Checkpoint |
|---|---|
| 1 Check whether the filter in cold water inlet is cleaned.<br>2 Check whether the gas supply pressure is adequate.<br>3 Check for cross connections between cold water lines and hot water lines. | |
| 4 Fault of PCB in the Water heater<br>[1] No voltage to gas solenoid valve ($SV_1$)<br>Normal: DC78～100V between COM (blue) & #9 (red)<br>(during operation)<br>[2] No voltage to gas solenoid valve ($SV_3$).<br>Normal: DC78～100V between COM (blue) & #73 (green)<br>(during operation) | C |
| 5 Gas solenoid valve ($SV_1$) fault<br>[1] No voltage to gas solenoid valve ($SV_1$)<br>Normal: 0.9～1.7kΩ between COM (blue) & #9 (red)<br>[2] No voltage to gas solenoid valve ($SV_3$)<br>Normal: 0.9～1.7kΩ between COM (blue) & #73 (green) | C |
| 6 PCB fault<br>No voltage to flow adjustment valve<br>Normal: DC 10.0～13.0V between (white-black)<br>Normal: DC 1V less between (yellow-black) | J1 |
| 7 Flow adjustment valve fault<br>Normal: 15～30Ω between (white-black) | J1 |

| Error Code | Malfunction description | Cancellation method |
|---|---|---|
| 031 | Dipswitch setting fault | Turn off the power or water supply |

| Diagnosis | Checkpoint |
|---|---|
| Check the dipswitch settings on PCB | |

| Error Code | Malfunction description | Cancellation method |
|---|---|---|
| 101 | Warning for the “991” error code<br>**(Refer to section 12-4)** | On the PCB, press the INC and DEC buttons simultaneously for 3 sec. Then turn the power off. |
| | **Diagnosis** | **Checkpoint** |
| | 1 Check the gas type of the Water heater.<br>2 Check how long the Water heater has been installed and in use.<br>3 Check the installation place.<br>4 Check the altitude/elevation of area of where the Water heater installed.<br>5 Check the vent length, when the Water heater has been installed indoors.<br>6 Check the type of vent cap, when the Water heater has been installed outdoors.<br>7 Check if there is any blockage in the intake air and/or exhaust.<br>8 Check if there is dust and lint in burner and heat exchanger, when the water heater has been installed in laundry room.<br>9 Check if there is grease and dirt in burner and fan motor, when the water heater has been installed in restaurant.<br>10 Check the manifold pressure in the Water heater. | |

| Error Code | Malfunction description | Cancellation method |
|---|---|---|
| 111<br><br>Error code is shown after three failed attempts at ignition | Ignition failure | Turn off the power or water supply |
| | **Diagnosis** | **Checkpoint** |
| | 1 Check gas supply and inlet pressure **(Refer to section 1)** | |
| | 2 Check the igniter **(Refer to section 10-17)**<br>Visual inspection: connection/breakage of wires and/or observed weak spark.<br>[1] Cracks/soot on igniter rod<br>[2] Improper gap between burner & igniter rod<br>Normal gap: 0.16"<br>[3] PCB fault<br>Normal: AC 90～110V at #7 (purple-purple) (during ignition)<br>[4] Igniter fault | B |

| Error Code | Diagnosis | Checkpoint |
|---|---|---|
| **111**<br><br>Error code is shown after three failed attempts at ignition | 3 PCB fault<br>[1] No voltage to main gas solenoid valve (MV)<br>Normal: DC78～100V between COM (blue) & #3 (light blue) (during operation)<br>[2] No voltage to gas solenoid valve ($SV_2$)<br>Normal: DC78～100V between COM (blue) & #53 (yellow) (during operation)<br>[3] No voltage to gas proportional valve ($VG_0$)<br>Normal: DC0.3～6.4V between white & red (during operation) | C<br><br>H1 |
| | 4 Gas solenoid valve fault<br>[1] Main gas solenoid valve (MV) fault<br>Normal: 0.9～1.7kΩ between COM (blue) & #3 (light blue)<br>[2] Gas solenoid valve ($SV_2$) fault<br>Normal: 0.9～1.5kΩ between COM (blue) & #53 (yellow)<br>[3] Gas proportional valve ($VG_0$) fault<br>Normal: DC0.3～6.4V between white & red (during operation) | C<br><br>H1 |
| | 5 Disconnected/damaged O.H.C.F. **(Refer to section 10-20)**<br>Visual inspection: connection/breakage of wires.<br>Normal: 1Ω or less between blue & blue | C2 |
| | 6 Disconnected/damaged hi-limit switch. **(Refer to section 10-19)**<br>Visual inspection: connection/breakage of wires.<br>Normal: 1Ω or less between red & red | C1 |
| | 7 Inspect flame rod<br>[1] Check for any soot on the rod.<br>[2] Check the connection of ground wire; make sure there is firm contact to the ground of the Water heater. (in this case, the wire is contacted to the manifold surface.)<br>[3] PCB fault<br>Not Burning (Stand-by):AC25～65V between (orange) & (green)<br>Burning: AC20～55V between (orange) & (green)<br>Not Burning (Stand-by): Less than DC 0.15μA between (orange) & (flame rod)<br>During operation: more than DC1μA through the flame rod wire (orange) & (flame rod)<br>[4] Flame rod fault | I |
| | 8 Check if hi-limit switch is properly functioning. | |

| Error Code | Malfunction description | Cancellation method |
|---|---|---|
| 121<br><br>Error code is shown after three failed attempts at ignition | Flame blows out | Turn off the power or water supply |
| | **Diagnosis** | **Checkpoint** |
| | 1 Check gas supply and pressure **(Refer to section 1)** | |
| | 2 PCB fault<br>[1] No voltage to gas main solenoid valve (MV)<br>Normal: DC78～100V between COM (blue) & #3 (light blue) (during operation)<br>[2] No voltage to gas solenoid valve ($SV_2$)<br>Normal: DC78～100V between COM (blue) & #53 (yellow) (during operation)<br>[3] No voltage to gas proportional valve ($VG_0$)<br>Normal: DC0.3～6.4V between white & red (during operation) | C<br><br><br><br><br><br>H1 |
| | 3 Gas solenoid fault<br>[1] Main gas solenoid valve (MV) fault<br>Normal: 0.9～1.7kΩ between COM (blue) & #3 (light blue)<br>[2] Gas solenoid valve ($SV_2$) fault<br>Normal: 0.9～1.5kΩ between COM (blue) & #53 (yellow)<br>[3] Gas proportional valve ($VG_0$) fault<br>Normal: DC0.3～6.4V between white & red (during operation) | C<br><br><br><br>H1 |
| | 4 Check for soot on the flame rod<br>[1] Clean the flame rod<br>[2] PCB fault<br>Not Burning (Stand-by):AC25～65V between (orange) & (green)<br>Burning: AC20～55V between (orange) & (green)<br>Not Burning (Stand-by): Less than DC 0.15μA between (orange) & (flame rod)<br>During operation: more than DC1μA through the flame rod wire (orange) & (flame rod)<br>[4] Flame rod fault | I |
| | 5 Disconnected/damaged O.H.C.F. **(Refer to section 10-20)**<br>Visual inspection: connection/breakage of wires.<br>Normal: 1Ω or less between blue & blue | C2 |

| Error Code | Malfunction description | Cancellation method |
|---|---|---|
| 141 | Hi-limit switch trip | Reset hi-limit switch |
| | **Diagnosis** | **Checkpoint** |
| | 1 Fault of hi-limit switch **(Refer to section 10-19)**<br>Visual inspection: connection/breakage of wires.<br>Normal: Less than 1 Ω between red & red | C1 |

| Error Code | Malfunction description | Cancellation method |
|---|---|---|
| 211 | Exhaust vent termination | Turn off the power or water supply |
| | **Diagnosis** | **Checkpoint** |
| | 1 Check for blockage of the exhaust run.<br>2 Check vent installation location for strong winds. | |
| | 3 Fault of pressure switch **(Refer to section 10-21)**<br>Visual inspection: connection/breakage of wires.<br>Normal: Less than 1 Ω between pink & pink | P |

| Error Code | Malfunction description | Cancellation method |
|---|---|---|
| 311 | Disconnected/short-circuited output thermistor | Turn off the power or water supply |
| | **Diagnosis** | **Checkpoint** |
| | 1 Output thermistor fault **(Refer to section 10-11)**<br>Visual inspection: connection/breakage of wires and/or debris on thermistor.<br>Check voltage/resistance between white & white (#12).<br>Refer to Section 8 for proper range of values. | E2 |

| Error Code | Malfunction description | Cancellation method |
|---|---|---|
| 321 | Disconnected/short-circuited inlet thermistor | Turn off the power or water supply |
| | **Diagnosis** | **Checkpoint** |
| | 1 Inlet thermistor fault **(Refer to section 10-11)**<br>Visual inspection: connection/breakage of wires and/or debris on thermistor.<br>Check voltage/resistance between white & white (#42).<br>Refer to Section 8 for proper range of values. | E3 |

| Error Code | Malfunction description | Cancellation method |
|---|---|---|
| 331 | Disconnected/short-circuited mixing thermistor | Turn off the power or water supply |
| | **Diagnosis** | **Checkpoint** |
| | 1 Mixing thermistor fault **(Refer to section 10-11)**<br>Visual inspection: connection/breakage of wires and/or debris on thermistor.<br>Check voltage/resistance between white & white (#113).<br>Refer to Section 8 for proper range of values. | E1 |

| Error Code | Malfunction description | Cancellation method |
|---|---|---|
| 391 | Disconnected thermocouple | Turn off the power or water supply |
| | **Diagnosis** | **Checkpoint** |
| | 1 Thermocouple fault **(Refer to section 10-22)**<br>Visual inspection: connection/breakage of wires. | O |

| Error Code | Malfunction description | Cancellation method |
|---|---|---|
| 441 | Flow sensor failure (Only multi-unit system) | Turn off the power or water supply |
| | **Diagnosis** | **Checkpoint** |
| | 1 Flow sensor fault **(Refer to section 10-8)**<br>Visual inspection: connection/breakage of wires and/or debris on impeller.<br>Check voltage/resistance between (red & black) or (white & black) | H2 |

| Error Code | Malfunction description | Cancellation method |
|---|---|---|
| 510 | Fault of driving circuit for main gas solenoid valve (MV)<br>(The computer checks the condition of the main gas valve immediately after every operation) | Turn off the power supply |
| | **Diagnosis** | **Checkpoint** |
| | 1 PCB and/or main gas valve fault **(Refer to section 10-4 & 10-13)**<br>Visual inspection of gas valves: connection/breakage of wires.<br>Normal: DC78～100V between COM (blue) & #3 (light blue) (during operation)<br>Visual inspection of PCB: connection/breakage of wires and/or burn marks on the computer board.<br>2 Main gas valve fault (MV) | C |

| Error Code | Malfunction description | Cancellation method |
|---|---|---|
| **541** | Fault of two-way valve<br>(The computer board cannot detect open and closed limit stops of the two-way valve within 18 sec.) | Turn off the power supply |
| | **Diagnosis** | **Checkpoint** |
| | 1 Fault of two-way valve **(Refer to section 10-10)**<br>Visual inspection: connection/breakage of wires and/or drive motor locked due to scale buildup and/or water leakage.<br>Normal: DC10.0～13.0V between red & blue (during operation)<br>Normal: DC14.0～16.0V between orange & gray (during operation)<br>Normal: Less than DC1V between yellow & gray<br>(valve in opened position)<br>Normal: Less than DC1V between brown & gray<br>(valve in closed position) | J3 |

| Error Code | Malfunction description | Cancellation method |
|---|---|---|
| **611** | Fan motor fault | Turn off the power or water supply |
| | **Diagnosis** | **Checkpoint** |
| | 1 PCB and fan motor fault **(Refer to section 10-3 & 10-13)**<br>Visual inspection of fan motor: connection/breakage of wires or dust buildup (causing electrical shortage)<br>Normal: DC 100～160V between red & blue (during operation)<br>Normal: DC 14～16V between yellow & blue (during operation)<br>Normal: DC 2.3～5.0V between orange & blue (during operation)<br>Normal: DC 4.0～15V between white & blue (during operation)<br><br>Verify fan motor speed of the Water heater using the "diagnostics mode" of the TM-RE10 or TM-RE30 temperature remote controller. See section 12-1. How to diagnose the Water heater using the TM-RE10 or TM-RE30".<br><br>Visual inspection of PCB: connection/breakage of wires and/or burn marks on the computer board. | G |

| Error Code | Malfunction description | Cancellation method |
|---|---|---|
| 651 | Flow adjustment valve fault | Turn off the power or water supply |
| | **Diagnosis** | **Checkpoint** |
| | 1 PCB and flow adjustment valve fault<br>**(Refer to section 10-7 & 10-13)**<br>Visual inspection of Flow adjustment valve: connection/breakage of wires, motor drive locked due to scale buildup, and/or water leakage.<br><br>Normal: DC 10.0～13.0V between (white-black)<br>Normal: DC 15～30Ω between (white-black)<br>Normal: Less than DC1V between (yellow-black)<br><br>Visual inspection of PCB: connection/breakage of wires and/or burn marks on the computer board. | J1 |

| Error Code | Malfunction description | Cancellation method |
|---|---|---|
| 661 | Bypass valve fault | Turn off the power or water supply |
| | **Diagnosis** | **Checkpoint** |
| | 1 Fault of PCB and bypass valve **(Refer to section 10-9 & 10-13)**<br>Visual inspection of bypass: connection/breakage of wires, motor drive locked due to scale buildup, and/or water leakage.<br><br>Normal: DC 12.0～14.5V between white-blue<br>Normal: DC 1.0～14.5V between blue-black<br>Normal: 27～33Ωbetween white-black<br>Normal: DC 1.0～14.5V between blue-orange<br>Normal: 27～33Ωbetween white-orange<br>Normal: DC 1.0～14.5V between blue-green<br>Normal: 27～33Ωbetween white-green<br>Normal: DC 1.0～14.5V between blue-purple<br>Normal: 27～33Ωbetween white-purple<br>Normal: DC 12.0～14.5V between red-blue<br>Normal: Less than DC1V between brown-blue (valve in open position)<br>Normal: DC 4.5～5.5V between yellow-blue<br><br>Visual inspection of PCB: connection/breakage of wires and/or burn marks on the computer board. | J2 |

| Error Code | Malfunction description | Cancellation method |
|---|---|---|
| 701 | 1 PCB fault<br>[1] Fault of preparation for the output thermistor operation<br>[2] Fault of driving circuit for Gas Proportional Valve($VG_0$) | Turn off the power or water supply |
| | **Diagnosis** | **Checkpoint** |
| | 1 Check the PCB and/or gas proportional valve<br>**(Refer to section 10-4 & 10-13)**<br>Visual inspection PCB: connection/breakage of wires and/or burn marks on the computer board.<br>Visual inspection gas proportional valve: connection/breakage of wires of the gas proportional valve.<br>Normal: 60～85Ω between (white) & (red) | H1 |

| Error Code | Malfunction description | Cancellation method |
|---|---|---|
| 721 | False flame detection | Turn off the power or water supply |
| | **Diagnosis** | **Checkpoint** |
| | 1 False flame detection (5 sec.)<br>Flame rod (Insulated resistance) fault | I |

| Error Code | Malfunction description | Cancellation method |
|---|---|---|
| 741 | Miscommunication between Water heater and temperature remote controller | Restoring proper cable connections between the Water heater and the Remote controller (TM-RE10 or TM-RE30). When the computer detects proper connections between the Water heater and the remote controller, "741" error code will cease to display. |
| | **Diagnosis** | **Checkpoint** |
| | 1 Temperature remote controller (TM-RE10 or TM-RE30) or PCB fault<br>2 Check for signs of power surges. | |

| Error Code | Malfunction description | Cancellation method |
|---|---|---|
| 761 | Miscommunication between multi-unit controller (TM-MC01 or TM-RE20) and Water heaters | Restoring proper cable connections between all the Water heater's and the multi-unit controller (TM-MC01 or TM-RE20). When the computer detects proper connections between the multi-unit controller and the Water heaters, "761" error code will cease to display. |
| | **Diagnosis** | **Checkpoint** |
| | 1 Inspect cable connections between Multiple controller (TM-MC01 or TM-RE20)<br>2 Check for signs of power surges. | |

| Error Code | Malfunction description | Cancellation method |
|---|---|---|
| 991 | Abnormal burning<br>**(Refer to section 12-4)** | Turn off the power or water supply<br>Press the reset button for 3 sec.<br>See section 12-4. |
| | **Diagnosis** | **Checkpoint** |
| | 1 Check the gas type of the Water heater.<br>2 Check how long the Water heater has been installed and in use.<br>3 Check the installation place.<br>4 Check the altitude/elevation of area of where the Water heater installed.<br>5 Check the vent length, when the Water heater has been installed indoors.<br>6 Check the type of vent cap, when the Water heater has been installed outdoors.<br>7 Check if there is any blockage in the intake air and/or exhaust.<br>8 Check if there is dust and lint in burner and heat exchanger, when the water heater has been installed in laundry room.<br>9 Check if there is grease and dirt in burner and fan motor, when the water heater has been installed in restaurant.<br>10 Check the manifold pressure in the Water heater. | |

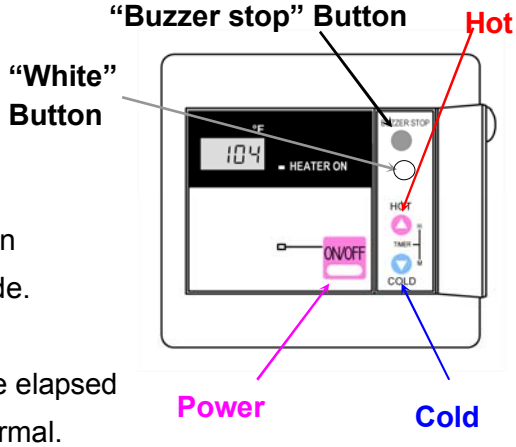
## 12. Controls and settings

12-1. (A)Diagnosing the T-M1 and T-M199 using the TM-RE10…… 54
12-1. (B)Diagnosing the T-M1 and T-M199 using the TM-RE30…… 55
12-2. Displaying error codes…… 58
12-3. Verifying functionality of computer board…… 60
12-4. Clearing the “101” and “991” error code…… 61
12-5. Thermocouple function…… 62
12-6. Dipswitch settings…… 63
12-7. Assigning unit numbers in the Multiple-system…… 65
12-8. T-M1 or T-M199 ON/OFF conditions: Overview…… 68
12-9. T-M1 or T-M199 ON/OFF conditions: BTU requirements for Intermittent mode…… 69
12-10. Multi-unit system ON/OFF conditions…… 70
12-11. Connections between Multi-unit controller and water heaters …… 72
12-12. Operation time for unit rotation…… 74
12-13. Individual unit operation in the Multiple-system while Multi-unit controller is under abnormal conditions (Individual operation mode)…… 75
12-14. Adjusting manifold gas pressure…… 76
12-15. Freeze protection system…… 78
12-16. Draining the T-M1 and T-M199 and cleaning the inlet water filter…… 80

## 12-1. (A) Diagnosing the T-M1 and T-M199 using the TM-RE10

### <For a single T-M1 or T-M199>

1. Press and hold the "**HOT**" and "**COLD**" buttons simultaneously for at least 5 seconds to enter "Diagnostics Mode".
2. Number "0" will be displayed. (Fig.1)
3. Scroll through the needed information (mode #) by pressing the "**HOT**" or "**COLD**" buttons to scroll up or down. (Fig.2)
4. Once desired mode # is displayed, press the white button located under the "**Buzzer Stop**" button to select the mode. The information for that mode will be displayed. (Fig.3)
5. When the "**ON/OFF**" button is pressed or 5 minutes have elapsed without pressing any buttons, the display will return to normal.



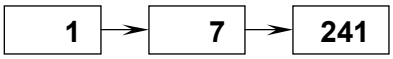




Fig.1 Fig.2 Fig.3

**For example, mode #7 will display the value of the electrical current of the AFR rod.**

### <For multiple T-M1 or T-M199's in the multi-unit system>

1. Press and hold the "**HOT**" and "**COLD**" buttons simultaneously for at least 5 seconds to enter "Diagnostics Mode".
2. Number "0" will be displayed. (Fig.1)
3. Scroll to the desired T-M1 or T-M199 unit # (either 1, 2, 3, or 20) by pressing the "**HOT**" or "**COLD**" buttons to scroll up or down.
   *#0 will yield information on the whole multi-unit system. (Fig.2)
4. Once desired # is displayed, press the white button located under the "**Buzzer Stop**" button to select the # (either a particular T-M1 or T-M199 unit or the whole multi-unit system). The number "1" will then display right next to that selected #. (Fig.3)
5. Scroll through the mode #'s by pressing the "**HOT**" or "**COLD**" buttons. (Fig.4)
6. Once desired mode # is displayed, press the white button located under the "**Buzzer Stop**" button to select the mode. The information for that mode will be displayed. (Fig.5)
7. When the "**ON/OFF**" button is pressed or 5 minutes have elapsed without pressing any buttons, the display will return to normal.

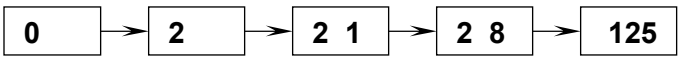



Fig.1 Fig.2 Fig.3 Fig.4 Fig.5

**For example, this sequence will display the flow rate information of the second T-M1 or T-M199 unit.**

## 12-1. (B) Diagnosing the T-M1 and T-M199 using the TM-RE30

### < For a single T-M1 or T-M199 >

1. Press the "**HOT**" button and the "**COLD**" button simultaneously for at least 5 seconds to enter “Diagnostic mode”.
2. Scroll up or down to the needed information (mode #) of the T-M1 or T-M199 by pressing the “**HOT**” or “**COLD**” buttons (Fig.1 shows mode #5 being selected.)
   **When selecting information, please refer to the table on p. 56 for the proper mode #.**
3. Press the “**INFO**” button to select the mode #, and the information to which the mode # correlates to will display on the TM-RE30 (Fig.2).
4. When the “**ON/OFF**” button is pressed or 5 minutes have elapsed without pressing any buttons, the display will return to normal.

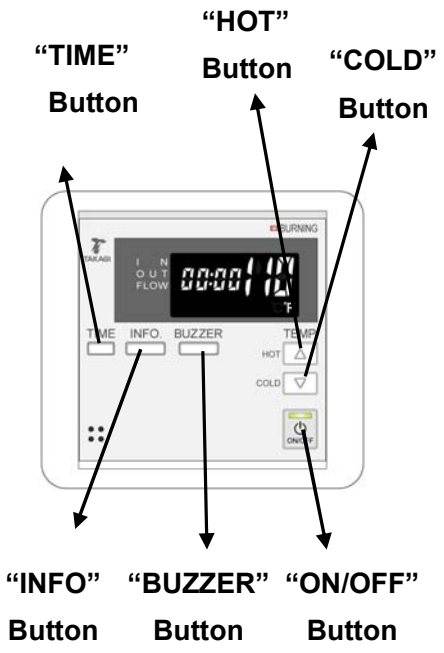


Fig.1

Fig.2

**< For multiple T-M1 or T-M199's in the Multi-unit system >**

1. Press and hold the "**HOT**" and "**COLD**" buttons simultaneously for at least 5 seconds to enter "Diagnostics Mode".
2. "0" will be displayed on the TM-RE30. (See Fig. 1)
3. Scroll to the desired T-M1 or T-M199 unit # in the multi-unit system by pressing the "**HOT**" or the "**COLD**" buttons to scroll up or down. (Fig. 2 shows that unit #2 is being selecting)

**NOTE:** The definition of the unit #'s:

"0" will yield information about the Multi-unit system as a whole, and numbers "1", "2", "3"…"20" will yield information about each of the individual T-M1 or T-M199's installed in the Multi-unit system.

In the Multi-unit system of T-M1 or T-M199's, a maximum of 20 T-M1 or T-M199's can be linked together.

4. Press the "**INFO**" button to select the desired unit #.
5. When the desired unit # is selected and fixed, scroll up or down to the needed information (mode #) of the unit by pressing the "**HOT**" or "**COLD**" buttons.
   (Fig.3 shows mode #6 is being selected.) **When selecting information, please refer to the table on the next page for the proper mode #.**
6. Press the "**INFO**" button to select the mode #, and information to which the mode # correlates to will display on the TM-RE30. (Fig. 4)
7. When the "**ON/OFF**" button is pressed or 5 minutes have elapsed without pressing any buttons, the display will return to normal.

Fig.1

Fig.2

Fig.3

Fig.4

For example, the figures above show how to arrive at the mixing temperature information for Unit #10 in a Multi-Unit System.

Description of mode numbers in “Diagnostics Mode”

| Mode# | Whole multi-unit system information (#0) | | Individual T-M1 or T-M199 unit information (#1 to #20) | |
|---|---|---|---|---|
| 1 | Total system flow rate | 0 to 9999 ( × 0.1 GPM) | Total operation time | 0 to 9999 (hours) |
| 2 | N / A | | ON/OFF cycles | 0 to 9999 ( × 100 times)<br>0 to 9 (times)<br>0 to 999( times) |
| 3 | Quantity of connected T-M1 or T-M199’s | 0 to 20 (units) | Fan motor speed | 0 to 9999 (rpm) |
| 4 | Priority T-M1 or T-M199 unit | 0 to 20 (units #) | Inlet temperature | 32 to 212 ºF<br>Over 212ºF=E5<br>Under 32ºF=E0 |
| 5 | Quantity of operational T-M1 or T-M199’s | 0 to 20 (units) | Output temperature | |
| 6 | Set temperature | 100 to 176 ºF | Mixing temperature | |
| 7 | Operation time during current rotation | 0 to 999 (minutes) | Thermocouple included voltage | 0 to 999 ( × 0.1 μ A) |
| 8 | ON/OFF cycles during current rotation | 0 to 999 (times) | Flow rate | 0 to 999 ( × 0.1 GPM) |
| 9 | N / A | | Bypass valve position | 0 to 9999, close position = 0 |
| 10(A)** | | | Ratio of hot water and cold water | 0 to 999 (%) |
| 11(b)** | | | Error code history: displays most recent error code | |
| 12(C)** | | | Error code history: displays 2nd most recent error code | |
| 13(d)** | | | Error code history: displays 3rd most recent error code | |
| 14(E)** | | | Clears memory in error code history | |
| 15(F)** | | | Clears memory in error code history | |
| 16(0)** | | | N / A | |

* **TM-RE30:** Simultaneously press the “**INFORMATION**” button and the “**BUZZER**” buttons on the TM-RE30 while in mode# 14 for at least 5 seconds to completely clear the memory in the error code history.
* **TM-RE10:** Simultaneously press the “**Buzzer stop**” button and the “**White**” button located under the “Buzzer stop” button on the TM-RE10 while in mode# E for at least 5 seconds to completely clear the memory in the error code history. “Buzzer stop" Button under button

** Mode #’s after #9 will be displayed as a number (e.g. “10”, “11”,……, “16”) on the TM-RE30. On the TM-RE10, Mode #’s after #9 will be displayed as hexadecimal values, going from “A” to “0”. After #16 (“0”), the TM-RE10 and the TM-RE30 will cycle back to #1 again.

## 12-2. Displaying error codes

If the T-M1 or T-M199 is undergoing abnormal conditions, the computer will display the error code to indicate the source of the problem. The error codes are displayed on the 7-seg LED of the T-M1 or T-M199 computer board and on the remote controller (TM-RE10 or TM-RE30). Please note that error codes are displayed differently, depending on where its being read, and whether it is a single-unit installation or a multi-unit installation.

### A. With a single-unit installation:

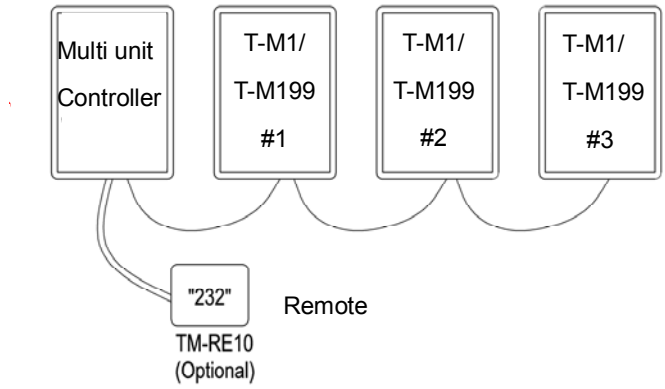
Example: If your unit fails on the "321" error (inlet thermistor)

- **T-M1 or T-M199 computer board**: The 7-Seg LED will flash the 3-digit error code one digit at a time. The 7-Seg LED will display "3"... "2"... "1" and will continually repeat these 3 digits.
- **TM-RE10 and TM-RE30**: The remote controller, however, will display "321" on its screen, in its entirety.

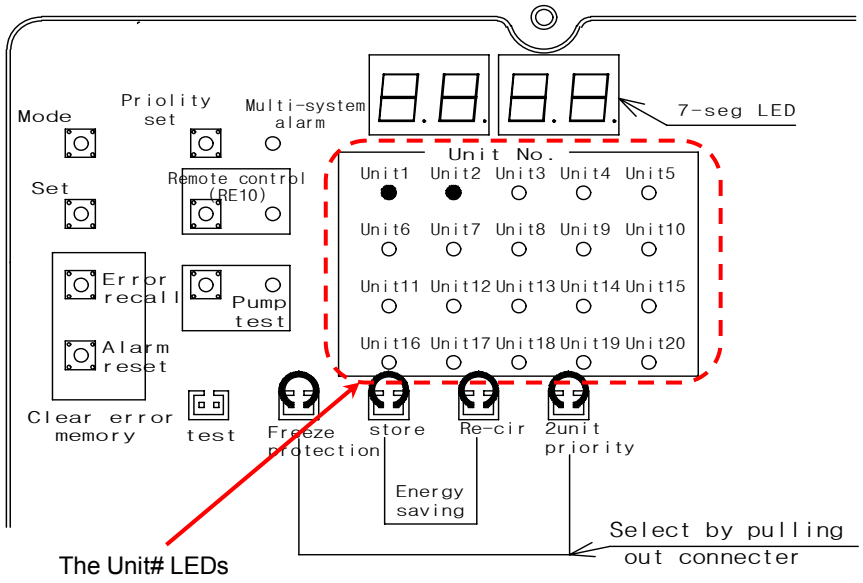
### B. With multi-unit system installations:

Example: If Unit #2 fails on the "321" error (inlet thermistor)

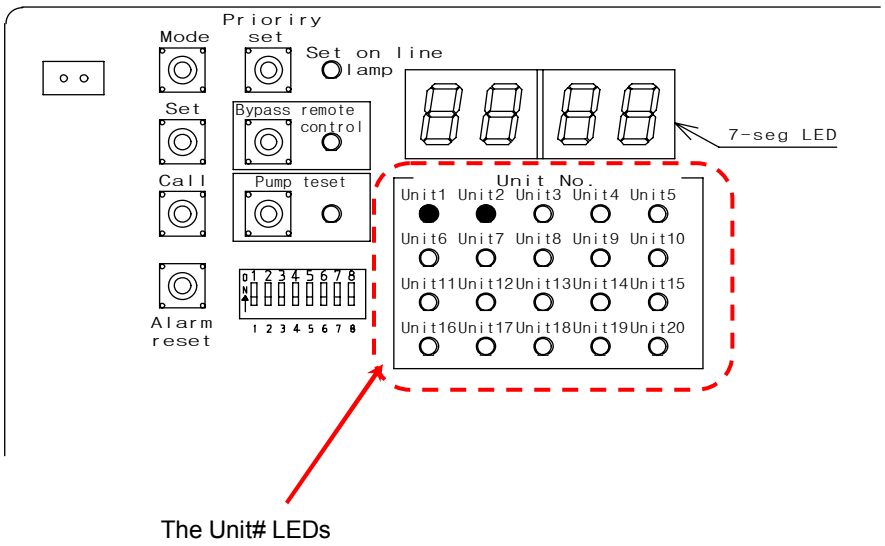
- **T-M1 or T-M199 computer board**: The unit that has the error in the multi-unit system will display the error code on its 7-Seg LED in exactly the same way as if it were only a single Unit. So, in this example, the 7-Seg LED on Unit #2 will display "3"…. "2"…. "1", just like in the single-unit example above.
- **TM-RE10 or TM-RE30**: The remote controller will display "232" on its screen in its entirety. The first "2" indicates that Unit #2 has the error. The "32" indicates the first two digits of the "321" error code.
- **TM-RE20 or TM-MC01**: The Unit # LED on TM-RE20 & TM-MC01 will flash to inform which T-M1 has the error code. The TM-RE20 and TM-MC01 do not display the actual error codes on its 7-seg LED. The TM-RE10 and TM-RE30 will display the error codes instead.



Computer board of **TM-RE20** multi-unit controller




Computer board of **TM-MC01** multi-unit controller



## 12-3. Verifying functionality of computer board

1. Check the power supply to the GFI
   (If the red light turns on after pressing the “test“ button on the GFI, the GFI is receiving power. After verifying power, press the “reset“ button to turn off the light.)

2. Press on GFI “RESET (ON)” button.

3. When the computer board works properly, this green LED will be lit.

## 12-4. Clearing the "101" and "991" error code

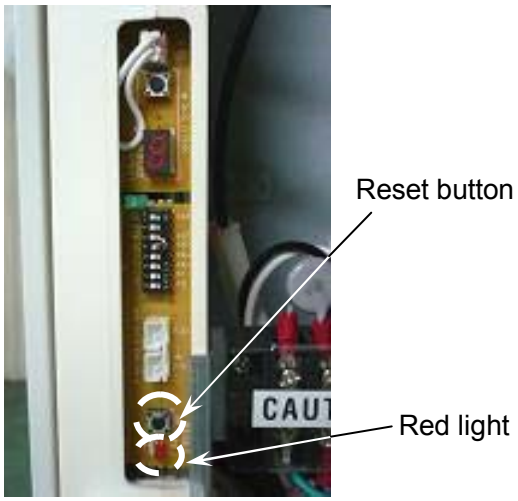
The T-M1 or T-M199's "101" and "991" error code signifies imperfect (abnormal) combustion, caused by insufficient intake air and/or obstructions in the exhaust.

A. **If the "101" and "991" error code occurs, please check the following:**

1. What is the T-M1 or T-M199's gas-type: liquid propane or natural gas?
2. How long has the T-M1 or T-M199 been installed and been in use?
3. Where is the T-M1 or T-M199 installed: indoor, outdoor, attic, etc?
4. What is the altitude/elevation of the area of installation?
5. If installed indoors, how long is the vent length?
6. If installed outdoors, what type of vent cap is used?
7. Are there any obstructions in the intake air and/or exhaust?
   - Damper sticking.
   - Vent Flaps installed on the Terminator.
   - Snow build up around Terminator.
   - Installed in a closet. (No Ventilation or lack of combustion air)
8. If installed in laundry room, check the burner and heat exchanger. Dust and lint may deposit in burner and heat exchanger.
9. If installed in restaurant, check the burner and fan motor. Grease and dirt may deposit in burner and fan motor.
10. Check if the manifold pressure of the Water heater is too high.

**B. How to clear the "101" and "991" error code (after resolving the main root cause of the error):**

On the computer board, press and hold the "**Reset**" button simultaneously for at least 3 seconds until the "**Red light**" turns on. Then press reset button on the GFI. The "101/"991" error code should then be cleared.



## 12-5. Thermocouple function

<Function>

The thermocouple checks flame conditions during combustion based on Seebeck effect (thermal electromotive force). When thermocouple detects unexpected flame conditions, the T-M1 or T-M199's computer makes adjustments in the fan motor speed to ensure that air and fuel are always at a proper mixture ratio, minimizing emissions.

< Thermocouple normal range of values>

(Unit: mV)

| Model | T-M1 | | T-M199 | |
|---|---|---|---|---|
| Gas type | LPG | Natural | LPG | Natural |
| MAX | 6～10 | 6～13 | 6～10 | 6～10 |

・If the voltage from thermocouple is higher than the normal value, the FM speed is increased.

・**<u>These values are read with the front cover close.</u>**

*The voltage from thermocouple can be confirmed in "Diagnostic Mode". (Refer to p. 57)

<Thermocouple stage (0～6) and "101" & "991" error codes>

| FM | Stage | |
|---|---|---|
| * | 6 | 991 Error code |
| +15% | 5 | 101 Error code |
| +12% | 4 | |
| +9% | 3 | |
| +6% | 2 | |
| +3% | 1 | |
| 0% | 0 | Default condition |

(Condition of Thermocouple stage)

・0: Default

・1～4: Gas-rich or Air shortage

In order to solve the "air deficiency" problem, the fan motor speed is automatically increased and Thermocouple stage goes up.

・5: "101" error code

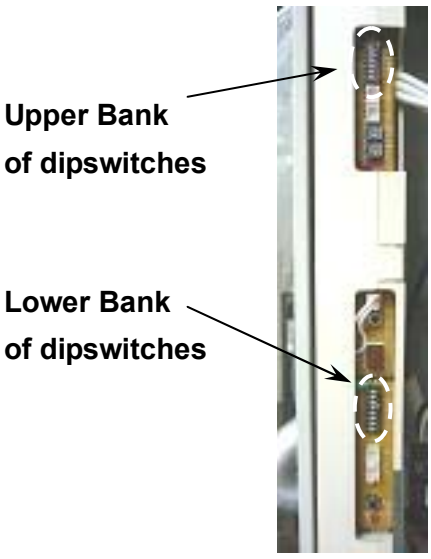
In this stage, the maximum input will be reduced to 88,000 BTU/h, but not apply in a multi-unit system (the maximum input will stay the same)

・6: "991" error code

・When the "101" or "991" error code appears, see section 12-4.

## 12-6. Dipswitch settings

There are two banks of dipswitches (upper and lower bank) on the T-M1 or T-M199 computer board. They have certain special functions as shown on the following table and generally should not need adjustment. Carefully verify the functions of each dipswitch before changing any settings.

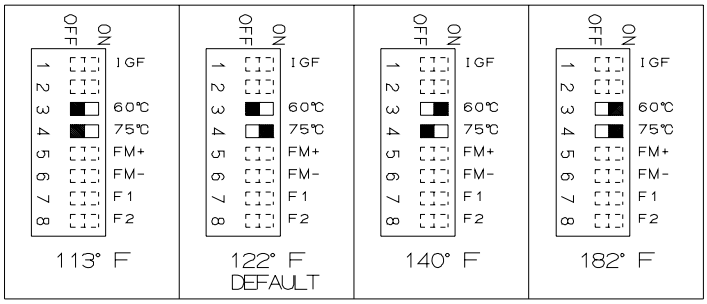



**The functions of the upper bank of dipswitches**

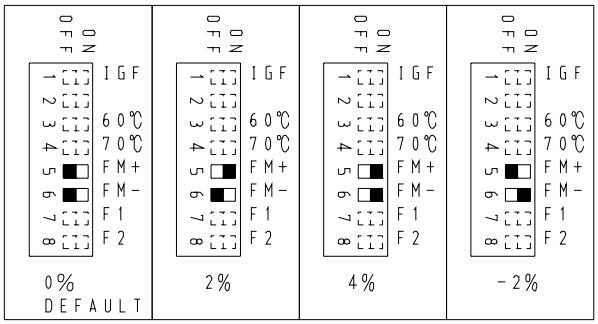
| No. | Functions | ON position | OFF position |
|---|---|---|---|
| 1 | Gas type | Propane | N / A |
| 2 | Gas type | Natural | N / A |
| 3-8 | N / A | N / A | N / A |

**The functions of the lower bank of dipswitches**

| No. | Functions | ON position | OFF position |
|---|---|---|---|
| 1 | N / A | N / A | N / A |
| 2 | N / A | N / A | N / A |
| 3<br>4 | Output temperature settings<br>(See table to the right)<br><br>(Default 122°F) | | |



| | | | |
|---|---|---|---|
| 5<br>6 | FM+ and FM-<br>(See the table to the right) | | |
| 7 | N / A | N / A | N / A |
| 8 | N / A | N / A | N / A |



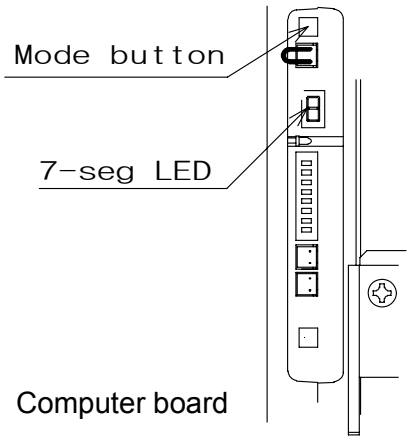
## 12-7. Assigning unit numbers in the Multiple-system

Each T-M1 or T-M199 in a Multiple-system is assigned a random unit #. This is why the T-M1 or T-M199's will not necessarily be numbered in order from left to right or right to left

### A. How to display the unit number

Press the "**mode button**" button on T-M1 or T-M199 computer board. The 7-seg LED will then display the assigned number for that T-M1 unit.

**NOTE:** In a single-unit installation, the numbering system is disabled.




### B. How to reset and reconfigure the numbering of units

The T-M1 or T-M199 can be connected with the Multi-unit controller (the TM-RE20 or the TM-MC01).

The unit# from the numbering system of TM-RE20 or TM-MC01 is assigned to each unit randomly, so they will not necessarily be in order from left to right. There are the procedures how to reset the unit# and to set it manually.

**Please refer to p.65 and p.66 for detail information.**

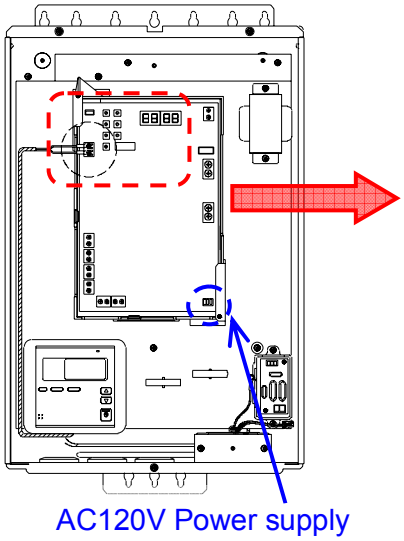
## Case1: The T-M1's or the T-M199's are connected with the TM-MC01.

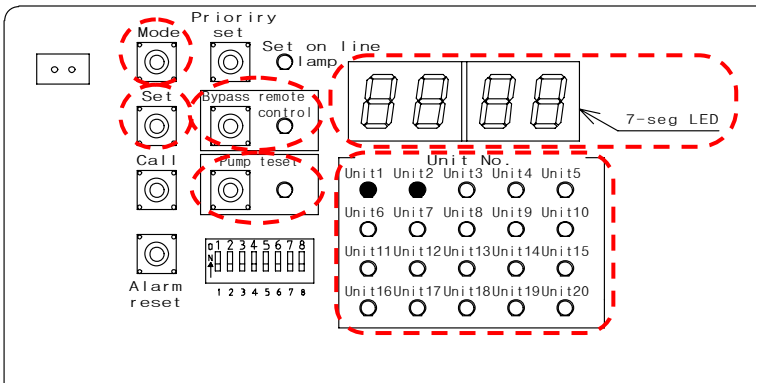
### (Clear the unit#)

1. Take off the front cover of the TM-MC01 Multi-unit controller and the T-M1s or T-M199s.
2. Press the **"MODE"** button on the computer board of the TM-MC01.
3. 7-seg LED on the computer board of the TM-MC01 will display "_0_ _".
4. Press the **"SET"** button.
5. 7-seg LED will display "_0_1".
6. Press the **"MODE"** button 9 times. (Then the "**7-seg LED**" will display "_0_A")
7. Press the **"SET"** button.
8. 7-seg LED will display "_ _FF".
9. Press the **"BYPASS REMOTE CONTROL"** button and the **"PUMP TEST"** at the same time. While pressing both buttons, the"**7-seg LED**" will display **"_CLR".** When you release the buttons, **"Unit No"** LED's of the TM-MC01 will turn off. Please wait until 7-seg LED display "0_ _0".

### (Set the Unit#)

10. Remove all the communication cable between the TM-MC01 and the T-M1s or T-M199s.
11. Reset the AC120V power supply of the TMMC01.
12. Select Unit#1 of the T-M1 or T-M199. Connect the communication cable between the TM-MC01 and T-M1 or T-M199 #1.
13. The "**Unit No**" LED on the computer board of the TM-MC01 will indicate light ON.
14. Connect the communication cable between unit #1 and the next T-M1 or T-M199 you wish to assign unit #2. Repeat this from #2 to #3 and so on.
15. Verify the unit # of each water heater.
    Press the "**Mode**" button on the computer board of each T-M1s or T-M199s and then the 7-seg LED on the T-M1 or T-M199 will display the set number




Computer board of the TM-MC01 multi-unit controller

**TM-MC01 multi-unit controller**

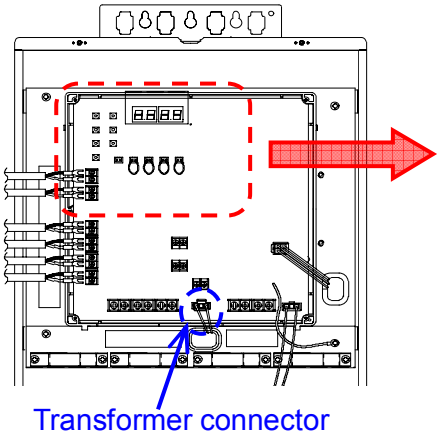
**Case2: The T-M1's or the T-M199's are connected with the TM-RE20.**

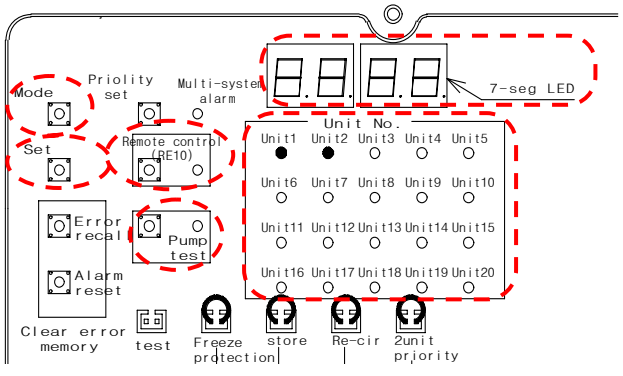
**(Clear the unit#)**

1. Take off the front cover of the TM-RE20 Multi-unit controller and the T-M1s or T-M199s.
2. Press the **"MODE**" button on the computer board of the TM-RE20.
3. 7-seg LED on the computer board of the TM-RE20 will display "_0_ _".
4. Press the **"SET"** button.
5. 7-seg LED will display "_0_1".
6. Press the **"MODE**" button 9 times. (Then the "**7-seg LED**" will display "_0_A")
7. Press the **"SET"** button.
8. 7-seg LED will display "_ _FF".
9. Press the **"REMOTE CONTROL"** button and the **"PUMP TEST"** button at the same time. While pressing both buttons, the"**7-seg LED**" will display **"_CLR".** When you release the buttons, **"Unit No"** LED's of the TM-RE20 will turn off. Please wait until 7-seg LED display "0_ _0".

**(Set the Unit#)**

10. Remove all the communication cable between the Multi-unit controller and the T-M1s or T-M199s.
11. Reset the transformer connector of the TM-RE20.
12. Select Unit#1 of the T-M1 or T-M199. Connect the communication cable between the TM-RE20 and T-M1 or T-M199 #1.
13. The "**Unit No**" LED on the computer board of the TM-RE20 will indicate light ON.
14. Connect the communication cable between unit #1 and the next T-M1 or T-M199 you wish to assign unit #2. Repeat this from #2 to #3 and so on.
15. Verify the unit # of each water heater.
    Press the "**Mode**" button on the computer board of each T-M1s or T-M199s and then the 7-seg LED on the T-M1 or T-M199 will display the set number




Computer board of the TM-RE20 multi-unit controller

**TM-RE20 multi-unit controller**

## 12-8. T-M1 or T-M199 ON/OFF conditions: Overview

The following table shows T-M1 or T-M199 ON/OFF conditions.
See the table below.

| ON/OFF Conditions | |
|---|---|
| **Conditions needed to turn the T-M1 or T-M199 ON.** | The BTU requirement is more than 14,875 BTU/h<br>AND<br>The water flow rate is more than 0.75 GPM |
| **Conditions needed to turn the T-M1 or T-M199 OFF** | The BTU requirement is less than 11,900 BTU/h, in this condition, when T-M1 or T-M199 computer board calculates a BTU, it will add 5.4˚F (3˚C) into the set temperature. Refer to section 12-9.<br>OR<br>Inlet temperature is higher than the set temperature<br>OR<br>Output temperature is over 194°F<br>OR<br>The water flow rate is less than 0.53 GPM |

## 12-9. T-M1 or T-M199 ON/OFF conditions: BTU requirements for Intermittent mode

### A. Calculating the T-M1 or T-M199's ON/OFF conditions

【Condition needed to turn the T-M1 or T-M199 ON】

( $T_{set}$ – $T_{in}$ ) × GPM × 500 > 14,880

and (Present inlet temp) < (Inlet temp when stopping a combustion) -5.4˚F

【Condition needed to turn the T-M1 or T-M199 OFF】

( $T_{set}$ +5.4˚F – $T_{in}$ ) × GPM × 500 < 11,900 or $T_{in} = T_{set}$

Where: $T_{set}$ = Set temperature and $T_{in}$ = Inlet temperature

### B. Calculation example

Set temperature: $T_{set}$ = 122˚F Flow rate = 2.5 GPM

【Condition needed to turn the T-M1 or T-M199 ON】

(122 – $T_{in}$ ) × 2.5 × 500 > 14,880 $T_{in}$ < 110.1˚F

【Condition needed to turn the T-M1 or T-M199 OFF】

(122 +5.4 - $T_{in}$ ) × 2.5 × 500 < 11,900 $T_{in}$ > 117.9 ˚F

The output temperature at that moment will be 134˚F

### C. ON/OFF table

| Set temperature (˚F) | | Flow rate (GPM) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |
| 113 | ON | 83.2 | 93.2 | 98.1 | 101.1 | 103.1 | 104.5 | 105.6 |
| | OFF | 94.6 | 102.5 | 106.5 | 108.9 | 110.5 | 111.6 | 112.4 |
| 122 | ON | 92.2 | 102.2 | 107.1 | 110.1 | 112.1 | 113.5 | 114.6 |
| | OFF | 103.6 | 111.5 | 115.5 | 117.9 | 119.5 | 120.6 | 121.4 |
| 131 | ON | 101.2 | 111.2 | 116.1 | 119.1 | 121.1 | 122.5 | 123.6 |
| | OFF | 112.6 | 120.5 | 124.5 | 126.9 | 128.5 | 129.6 | 130.4 |
| 140 | ON | 110.2 | 120.2 | 125.1 | 128.1 | 130.1 | 131.5 | 132.6 |
| | OFF | 121.6 | 129.5 | 133.5 | 135.9 | 137.5 | 138.6 | 139.4 |
| 158 | ON | 128.2 | 138.2 | 143.1 | 146.1 | 148.1 | 149.5 | 150.6 |
| | OFF | 139.6 | 147.5 | 151.5 | 153.9 | 155.5 | 156.6 | 157.4 |
| 167 | ON | 137.2 | 147.2 | 152.1 | 155.1 | 157.1 | 158.5 | 159.6 |
| | OFF | 148.6 | 156.5 | 160.5 | 162.9 | 164.5 | 165.6 | 166.4 |
| 182 | ON | 155.2 | 162.2 | 167.1 | 170.1 | 172.1 | 173.5 | 174.6 |
| | OFF | 163.6 | 171.5 | 175.5 | 177.9 | 179.5 | 180.6 | 181.4 |

## 12-10. Multi-unit system ON/OFF conditions

In the Multi-unit systems, the amount of T-M1 or T-M199's called on to activate depends on the **"FLOW RATE"** and the **"SET TEMPERATURE"**.

1. Condition required to activate an additional T-M1 or T-M199:

**Flow rate required to activate additional T-M1 or T-M199 = A × n**

Where **n** = number of currently activated T-M1 or T-M199's

and **A** is dependent on the set temperature. See table below:

| Set temperature | | **Factor "A"** | |
|---|---|---|---|
| °F | °C | GPM | L/min |
| 100 - 122 | 37 - 50 | 3.4 | 13 |
| 131 | 55 | 3.2 | 12 |
| 140 | 60 | 2.9 | 11 |
| 149 | 65 | 2.6 | 10 |
| 158 - 182 | 70 - 80 | 2.4 | 9 |

2. Condition required to reduce the number of activated T-M1 or T-M199's:

A. **In the case of reducing down from 2 T-M1 or T-M199's to 1 T-M1 or T-M199: Flow rate = A / 1.7**

B. **All other cases: Flow rate = A × (n - 2)**

3. Example: Set temperature = 122°F in a 20-unit system and priority unit is No. 1

(See the next page)

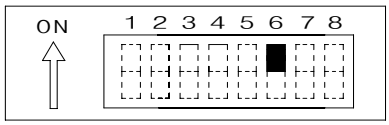
| To activate additional T-M1 or T-M199's | | | To reduce number of activated T-M1'or T-M199's | | |
|---|---|---|---|---|---|
| Unit No. | Flow rate | | Unit No. | Flow rate | |
| | GPM | L/min | | GPM | L/min |
| No.1 ON | 0.75 | 3.0 | No.20 OFF | 61.2 | 231.6 |
| No.2 ON | 3.4 | 12.9 | No.19 OFF | 57.8 | 218.8 |
| No.3 ON | 6.8 | 25.7 | No.18 OFF | 54.4 | 205.9 |
| No.4 ON | 10.2 | 38.6 | No.17 OFF | 51.0 | 193.0 |
| No. 5 ON | 13.6 | 51.5 | No.16 OFF | 47.6 | 180.2 |
| No. 6 ON | 17.0 | 64.3 | No.15 OFF | 44.2 | 167.3 |
| No. 7 ON | 20.4 | 77.2 | No.14 OFF | 40.8 | 154.4 |
| No. 8 ON | 23.8 | 90.0 | No.13 OFF | 37.4 | 141.6 |
| No.9 ON | 27.2 | 103.0 | No.12 OFF | 34.0 | 128.7 |
| No.10 ON | 30.6 | 115.9 | No.11 OFF | 30.6 | 115.8 |
| No.11 ON | 34.0 | 128.7 | No.10 OFF | 27.2 | 103.0 |
| No.12 ON | 37.4 | 141.6 | No.9 OFF | 23.8 | 90.1 |
| No.13 ON | 40.8 | 154.4 | No.8 OFF | 20.4 | 77.2 |
| No.14 ON | 44.2 | 167.3 | No.7 OFF | 17.0 | 64.3 |
| No.15 ON | 47.6 | 180.2 | No.6 OFF | 13.6 | 51.5 |
| No.16 ON | 51.0 | 193.0 | No.5 OFF | 10.2 | 38.6 |
| No.17 ON | 54.4 | 205.9 | No.4 OFF | 6.8 | 25.7 |
| No.18 ON | 57.8 | 218.8 | No.3 OFF | 3.4 | 12.9 |
| No.19 ON | 61.2 | 231.6 | No.2 OFF | 2.0 | 7.6 |
| No.20 ON | 64.6 | 244.5 | No.1 OFF | 0.53 | 3.0 |

## 12-11. Connections between Multi-unit controller and water heaters

The T-M1, T-M199, and T-M32 can be intermixed with each other in a Multi-unit system, using either Multi-unit controller (TM-MC01 or TM-RE20).

### <Connection between the Water heaters and the TM-MC01 >

**If a multi-unit system contains either a T-M1 or T-M199 and the TM-MC01 is used as the controller, change dipswitch No.6 on the TM-MC01 computer board to the "ON" position**




**Dipswitch setting on the TM-MC01**

**NOTICE: No dipswitch changes are needed when using the TM-RE20**

When the T-M1 or T-M199 is connected with any T-M32 as part of a Multi-unit system with the TM-RE10 or the TM-RE30 temperature remote controllers, the available set temperatures will default to what is available on a T-M1 or T-M199 (from 99ºF to 167ºF/182ºF as shown below).

**Temperatures available under the Default**

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 99 | 100 | 102 | 104 | 106 | 108 | 110 | 111 | 113 | 115 | 117 | 122 | 131 | 140 | 158 | 167 |

**Temperatures available under the High Temperature Mode**

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 99 | 100 | 102 | 104 | 106 | 108 | 110 | 111 | 113 | 122 | 131 | 140 | 149 | 158 | 167 | 182* |

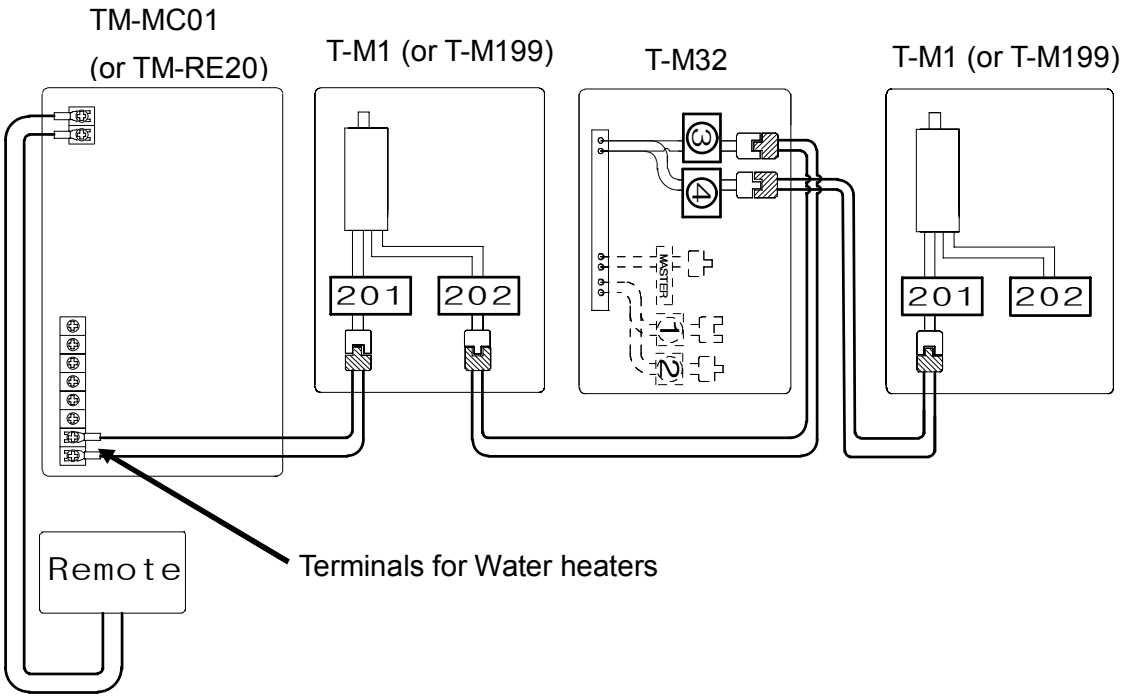
*The maximum set temperature with the TM-RE10

When the red jumper on the back of the TM-RE10 is installed, the maximum set temperature is 167 ºF. If you remove the jumper, the maximum set temperature will be 182 ºF.

When the set temperature is 182 ºF, "H" is displayed on the TM-RE10.

**< Connection Diagram between Water heaters and Multi-Unit controller>**

The diagram below shows an example of how to connect between different water heaters (the T-M1, the T-M199, or the T-M32) and the Multi-Unit Controller (the TM-MC01 or the TM-RE20) in a Multi-unit system.




<Connection between the Multi-Unit controller and different water heaters (T-M1, T-M199, and T-M32)>

- When the TM-MC01 is connected directly to the T-M1 or T-M199, connect the "**Terminals for Water heaters**" in the **Multi-Unit controller** to the "**[201] connector**" in the **T-M1** or T-M199.
- When the TM-MC01 is connected directly to the T-M32, connect the "**Terminals for Water heaters**" in the **TM-MC01** to the "**[3] connector**" in the **T-M32**.

<Connections between the T-M1 (or T-M199) and the T-M32>

- If the T-M1 (T-M199) is the first unit connected to the multi-unit controller, connect the "**[202] connector**" in the **T-M1** or **T-M199** to the "**[3] connector**" in the **T-M32** that is next in line.
- If the T-M32 is the first unit connected to the multi-unit controller, connect the "**[4] connector**" in the **T-M32** to the "**[201] connector**" in the **T-M1** or **T-M199** that is next in line.

<Connections between the T-M1 and the T-M199>

- Connect the "**[202] connector**" in the **T-M1** to the "**[201] connector**" in the **T-M199** next in line .
- Connect the "**[202] connector**" in the **T-M199** to the "**[201] connector**" in the **T-M1** next in line .

## 12-12. Operation time for unit rotation

The Multi-Unit controller (the TM-RE20 and the TM-MC01) controls T-M1s or T-M199s in the Multi unit system operations.
The priority unit will rotate when it reaches 100 ON/OFF cycles or after 12 hours of operation.

NOTE: The priority unit is the unit that turns on first when there is a hot water demand.
When there is a black out and/or cut off for over 50 minutes, priority unit will switch back to # 1 unit. (Default)

**Example: 4 T-M1 or T-M199s Rotation**

A rotation occurs when:

ON/OFF cycles (×100 times) or Hours of operation (12 hours)

| | Unit No.1 | Unit No.2 | Unit No.3 | Unit No.4 |
|---|---|---|---|---|
| Unit priority | 1 | 2 | 3 | 4 |

Next step

| | | | | |
|---|---|---|---|---|
| Unit priority | 4 | 1 | 2 | 3 |

Next step

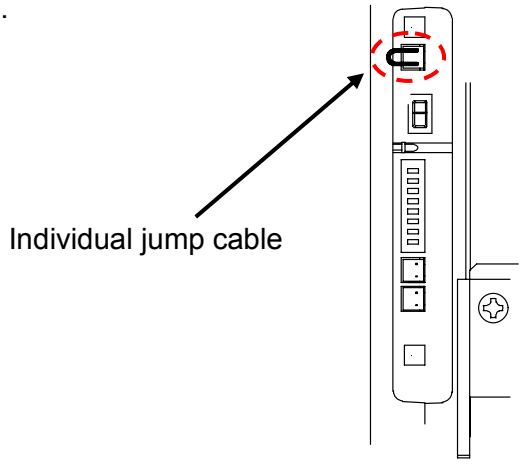
| | | | | |
|---|---|---|---|---|
| Unit priority | 3 | 4 | 1 | 2 |

## 12-13. Individual unit operation in the Multiple-system while Multi-unit controller (the TM-RE20 or the TM-MC01) is under abnormal conditions (Individual operation mode)

A multi-unit system of T-M1 or T-M199s requires the Multi-unit controller. If the Multi-unit controller undergoes abnormal conditions, the T-M1 or T-M199s can operate as individual units. If this happens, the minimum flow rate of the system changes from 0.75 GPM to 0.75 GPM multiplied by the number of T-M1 or T-M199s. Refer to the following example:

Ex: Minimum flow rate of the a 5-unit multi-unit system.
Under normal conditions: 0.75GPM
When the Multi-unit controller fails: 0.75×5=3.75GPM

- Minimum flow rate of the multiple-system depends on the number of the units installed in the multiple-system.
- The set temperature of the units as individual units is the set temperature before the failed communication happened between T-M1 or T-M199 and the Multi-unit controller.
- T-M1 or T-M199s will not work individually during with a failed Multi-unit controller if the "**Individual jump cable**" on the T-M1 or T-M199 computer board is removed. See the picture below.
- In order to make operation system effective during an abnormal condition, the number of individual unit should be half of the total number of T-M1 or T-M199 installed in multiple-system.



## 12-14. Adjusting manifold gas pressure

The manifold gas pressure on the T-M1 or T-M199 can be adjusted by following the procedures below.

**WARNING**

Adjusting the manifold pressure can cause unexpected combustion conditions during operation, which can cause a health hazard, damage the T-M1 or T-M199, and/or shorten its lifespan. Therefore, changing the manifold pressure is not recommended unless there are very strong reasons to do so (e.g. high elevation installations), and with the consultation of Takagi USA.

### Adjusting maximum manifold pressure

1. Ensure that T-M1 or T-M199 is not in operation.
2. Remove the screw off the manifold port of the T-M1 or T-M199. (Figure 1)
3. Connect a manometer to the manifold port using a tube (Figure 2). Ensure that this connection is secure enough to prevent gas leak.
4. Run water through the T-M1 or T-M199 to activate its operation. If presence of a gas leak is detected, immediately shut off the T-M1 or T-M199 and inspect the tube/manifold connection; otherwise, proceed onto the next step.
5. To increase the manifold gas pressure, insert the "**Manifold gas pressure Jumper**" (see next page, Figures 3 & 4) into the **"Max port"** and turn the **"Maximum potentiometer"** clockwise. To decrease the manifold gas pressure, turn the **"Maximum potentiometer"** counter-clockwise.
6. After gas pressure has been set, deactivate the T-M1 or T-M199, remove the manometer tube, and replace the port screw.

### Adjusting minimum manifold pressure

1. Ensure that T-M1 or T-M199 is not in operation.
2. Remove the screw off the manifold port of the T-M1 or T-M199. (Figure 1)
3. Connect a manometer to the manifold port using a tube (Figure 2). Ensure that this connection is secure enough to prevent gas leak.
4. Run water through the T-M1 or T-M199 to activate its operation. If presence of a gas leak is detected, immediately shut off the T-M1 or T-M199 and inspect the tube/manifold connection; otherwise, proceed onto the next step.
5. To increase the manifold pressure, insert the "Manifold gas pressure Jumper" (see next page,

Figures 3 & 4) into the “Min port” and turn the “Minimum potentiometer” clockwise. To decrease the manifold gas pressure, turn the “Minimum potentiometer” counter-clockwise.

6. After gas pressure has been set, deactivate the T-M1 or T-M199, remove the manometer tube, and replace the port screw.

Figure1

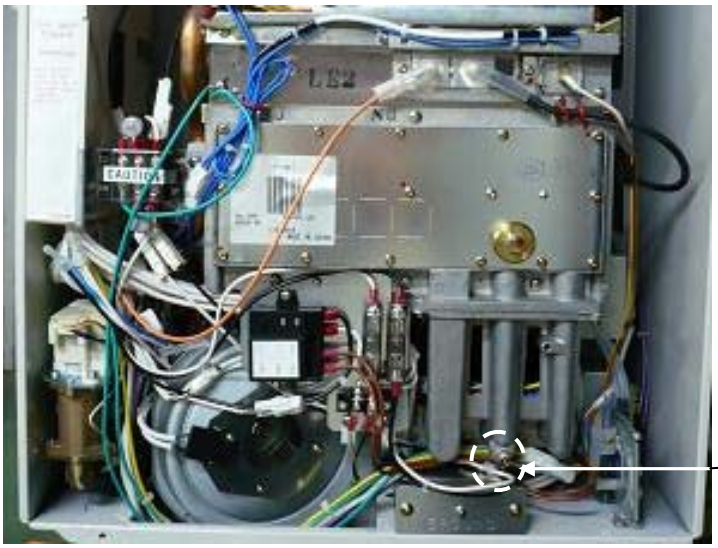
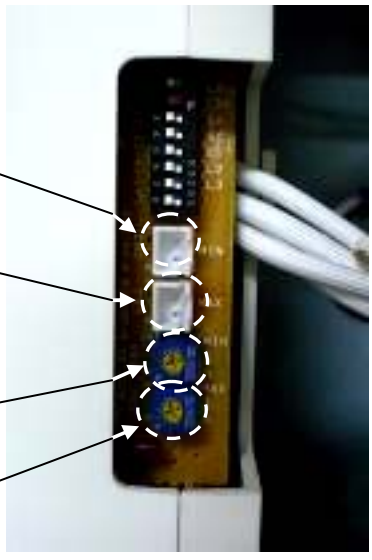



Figure 3

Figure 2

Figure 4



## 12-15. Freeze protection system

There are two features to the T-M1 or T-M199's freeze protection system: the automatic fan motor system and the ceramic heating blocks. The automatic fan motor system allows the T-M1 or T-M199 to briefly do fan motor operation and the ceramic heating blocks will heat up whatever portion of the heat exchanger the blocks are strapped to.
The automatic fan motor mainly focuses on providing freeze protection from the back flow of the venting. The seven heating blocks focus on protecting the inlet and outlet piping inside the T-M1 or T-M199, as well as the front drum pipe. The conditions to activate either feature are different from each other. However, the two features are not mutually exclusive, because they focus on different areas of the T-M1 or T-M199. As long as each particular feature's activation requirements are met, it is possible for both features to operate at the same time.

### Ceramic heating blocks

- Electrical power is required for this feature to operate.
- The blocks will activate based on what the freeze protection thermostat senses or all thermistors. The thermostat is located on the fan motor.

**<Activate condition>**

$T_{in} \leq 39°F$ **OR** $T_{out} \leq 39°F$ **OR** $T_{MIX} \leq 39°F$ **OR** $T_{thermostat} < 36.5°F$

where $T_{in}$ is the temperature of inlet thermistor and $T_{out}$ is the temperature of the output thermistor and $T_{thermostat}$ is the temperature of the thermostat.

**<Deactivate condition>**

$T_{in} \geq 46°F$ and $T_{out} \geq 46°F$ and $T_{MIX} \geq 46°F$

**OR**

$T_{in} > 39°F$ and $T_{out} > 39°F$ and $T_{MIX} > 39°F$ and "Flow sensor detects flow rate for 1min"

**OR**

$T_{in} < T_{out}$

where $T_{in}$ is the temperature of inlet thermistor and $T_{out}$ is the temperature of the output thermistor and $T_{MIX}$ is the temperature of the mixing thermistor.

## Automatic fan motor system

- Electrical power is required for this feature to operate.
- The computer will continually check the temperatures of the inlet, outlet and mixing thermistors.
- This function is enabled by the "**Automatic fan motor connector**" inserted on the computer board. (See a next page)

### <Activate condition>

When the computer checks for these temperatures, the Automatic fan motor system will activate if:

$$T_{out} \leqq 39°F \quad \textbf{AND} \quad T_{out} \leqq T_{in} - 5°F$$

where $T_{in}$ is the temperature of inlet thermistor and $T_{out}$ is the temperature of the output thermistor.

### <Deactivate condition>

When the computer checks for these temperatures, the Automatic fan motor system will activate if:

$$T_{in} \geqq 46°F \text{ and } T_{out} \geqq 46°F \text{ and } T_{MIX} \geqq 46°F$$

**OR**

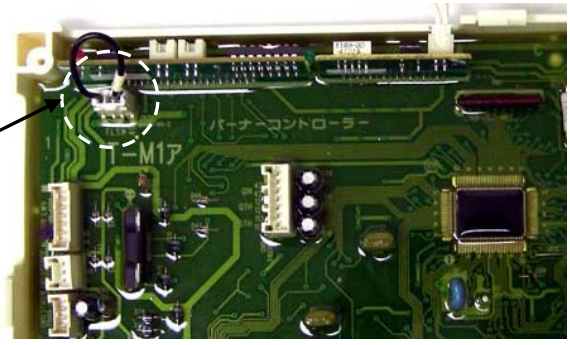
$T_{in} > 39°F$ and $T_{out} > 39°F$ and $T_{MIX} > 39°F$ and "Flow sensor detects flow rate for 1min"

**OR**

$$T_{in} < T_{out}$$

where $T_{in}$ is the temperature of inlet thermistor and $T_{out}$ is the temperature of the output thermistor and $T_{MIX}$ is the temperature of the mixing thermistor.

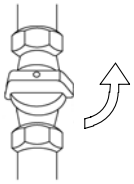
Automatic fan motor connector



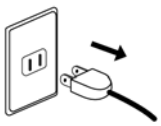

Computer board

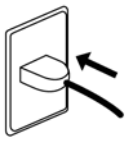
## 12-16. Draining the T-M1, T-M199 and cleaning the inlet water filter

**1.** Close the manual gas shut off valve.

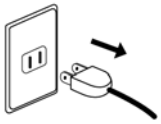


**2.** Turn off power to the T-M1 or T-M199, and then turn on again.

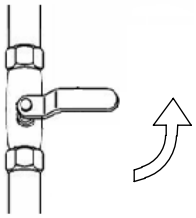




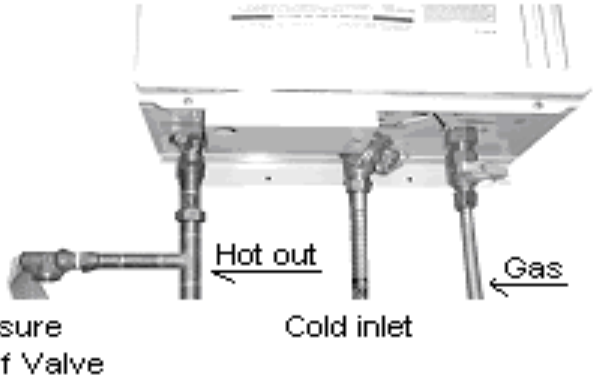
**3.** Wait 30 seconds for water valves starts to completely open.
Then turn off power to the T-M1 or T-M199, yet again.



**4.** Close the water shut-off valve.



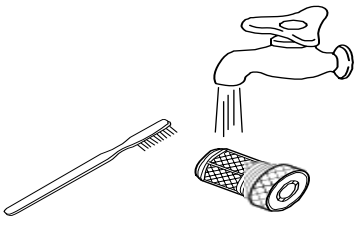
**5**. Open all hot water taps in the house. When the all water flow has ceased, close all hot water taps.




**6.** Have a bucket or pan to catch the water from the T-M1 or T-M199's drain plugs. **Unscrew** the drain plugs to drain all the water out of the T-M1 or T-M199.

**7.** Wait a few minutes to ensure all water has completely drained from unit.

**8. Clean the filter:** Inspect the water filter located within the cold inlet. With a tiny brush, clean the water filter of any debris which may have accumulated and reinsert the filter back into the cold water inlet.

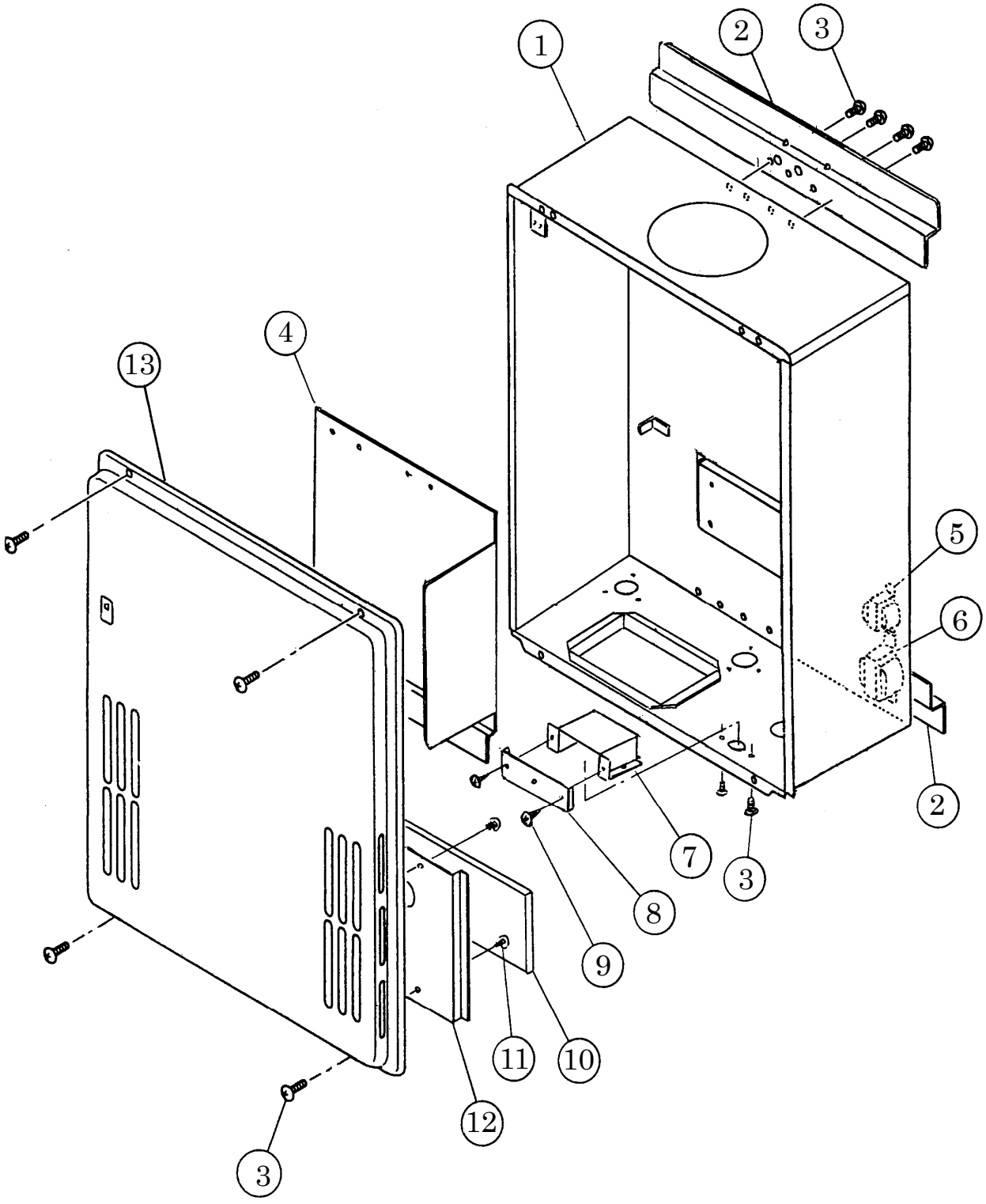


**9.** Securely screw the drain plugs back into place. **Hand- tighten only.**

## 13. Components diagrams

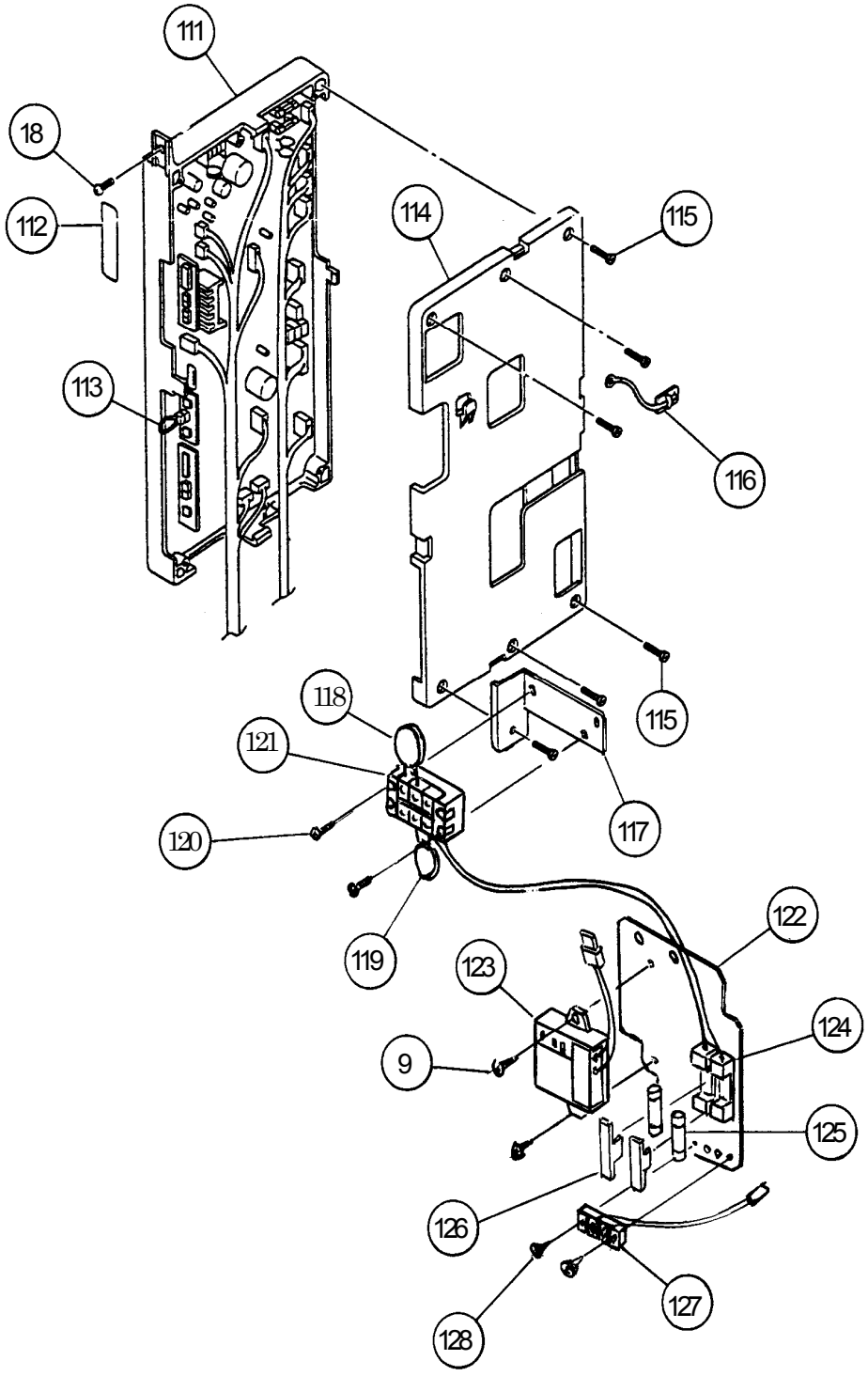
### Case assembly

Other than the case assembly (No.1) and front cover (No.13), the T-M1 and T-M199 share the

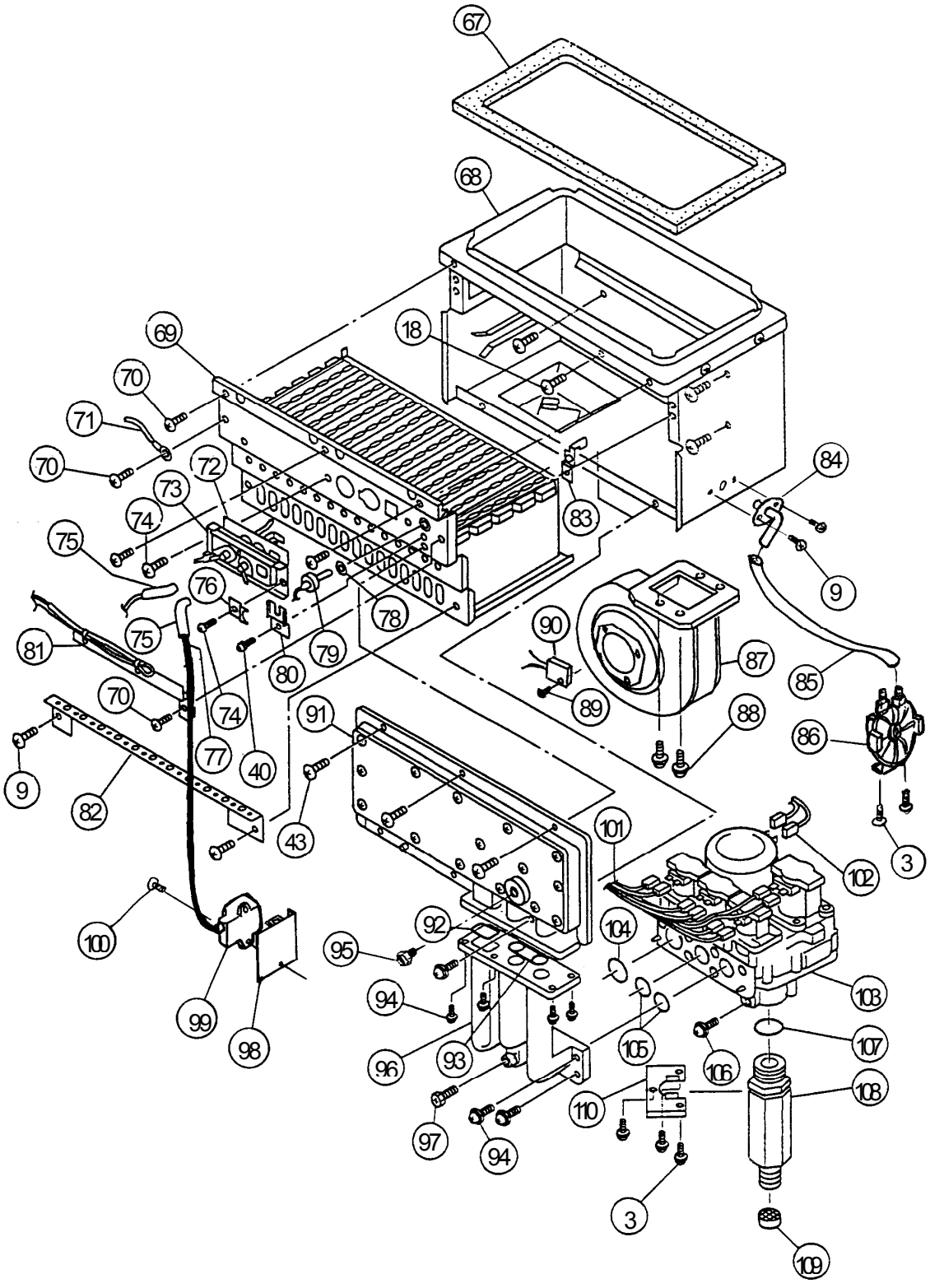


## Computer board assembly

Other than Part# 111, the T-M1 and T-M199 share the same components.

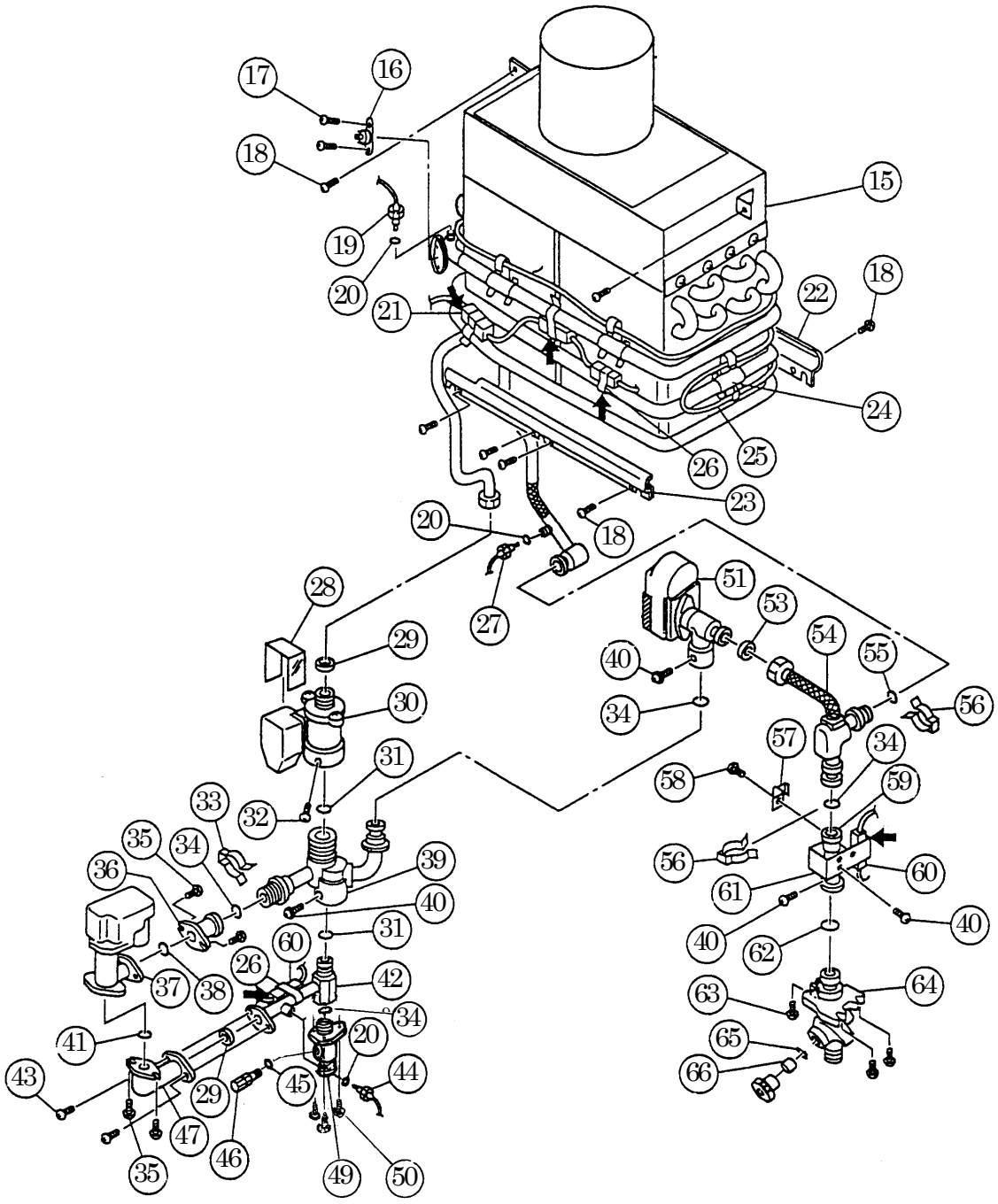


## Burner assembly



## Water way assembly

Other than the heat exchanger assembly (No.15), the T-M1 and T-M199 share the same components.



## 14. Parts list

Other than the case assembly (No.1), front cover (No.13), heat exchanger assembly (No.15) and computer board (No.111), all of the T-M199's components are the same as the T-M1.

| Item # | Part # | Description | Common parts for other units |
|---|---|---|---|
| 1 | EM103 (T-M1)<br>EM232 (T-M199) | Case Assembly | |
| 2 | EM104 | Bracket | TH1,TM32 |
| 3 | EW001 | Screw M4×10 (w/washer) | * |
| 4 | EM185 | Back guard panel | |
| 5 | EM164 | Computer transformer<br>(TD1-205) | |
| 6 | EM163 | Transformer<br>(TD1-203) | |
| 7 | EK061 | Junction Box | TK2, TKD20 |
| 8 | EK062 | Junction Box Cover | TK2, TKD20 |
| 9 | EW003 | Screw M4 x 10 | * |
| 10 | EM148 | Sound Insulation | |
| 11 | EA126 | Screw M4 x 8 (Coated) | * |
| 12 | EM107 | Weather Protection Panel | |
| 13 | EM105 (T-M1) | Front cover | |
| | EM233 (T-M199) | | |
| 15 | EM112 (T-M1)<br>EM240 (T-M199) | Heat Exchanger Assembly | |
| 16 | EM212 | Hi-Limit Switch | TK2,TKD20 |
| 17 | EW00A | Screw M3 x 6 | * |
| 18 | EW002 | Screw M4 x 10 (Coated) | * |
| 19 | EM186 | Output thermistor | |
| 20 | EZM04 | O-ring P4 EPDM<br>(Purple) | TK2,TKD20,TKJr,TK1S,OS,SP,<br>TH1,TM50,TM32,T-K3,Pro |
| 21 | EM166 | Heater Block 604 | |
| 22 | EK026 | Heat Exchanger Fixing Plate<br>(Back) | |

| Item # | Part # | Description | Common parts for other units |
|---|---|---|---|
| 23 | EK028 | Heat exchanger fixing plate (Front) | |
| 24 | EK029 | Fuse fixing plate 14 | OS,SP,TK2,TKD20,TK1S,TKJr,TK3,Pro |
| 25 | EM138 | Overheat-cut-off-fuse | |
| 26 | EK031 | Heater fixing plate 16 | TK2, TKD20,TM50,TM32 |
| 27 | EM187 | Inlet thermistor | TK2, TKD20 |
| 28 | EM188 | Two way valve cover | |
| 29 | EM189 | Silicon O-ring M26 | |
| 30 | EM118 | Two way valve assembly | |
| 31 | EZV20 | O-ring P20 EPDM | |
| 32 | EA126 | Screw M4 x 8 (Coated) | * |
| 33 | EM190 | Quick release plate | |
| 34 | EZN16 | O-ring JASO#1016 EPDM (Purple) | TH1, TK2,TKD20,TM32 |
| 35 | EX013 | Screw M4 x 12 | * |
| 36 | EM169 | Flange | |
| 37 | EM120 | Flow adjustment valve | |
| 38 | EZM16 | O-ring P16 EPDM (Purple) | TK2,TKD20,TKJr,TK1S,TK3,OS,SP, TH1,TM50,TM32,Pro |
| 39 | EM115 | Bypass junction | |
| 40 | EW009 | Screw M4 x 6 | * |
| 41 | EZV18 | O-ring P18 EPDM | |
| 42 | EM119 | Water outlet connection | |
| 43 | EW00E | Screw M4 x 14 | * |
| 44 | EM179 | Mixing thermistor | |
| 45 | EZM06 | O-ring P6 EPDM (Purple) | TK2,TKD20,TKJr,TK1S,OS,SP, TK3,Pro,TH1,TM50,TM32 |
| 46 | EK046 | Outlet drain plug | |
| 47 | EM170 | Mixing connection pipe | |
| 49 | EM100 | Water Outlet | |
| 50 | EW000 | Screw M4 x 12 (w/washer) | * |

| Item # | Part # | Description | Common parts for other units |
|---|---|---|---|
| 51 | EM116 | Bypass valve | |
| 53 | EK024 | Silicon O-ring M22 | |
| 54 | EM114 | Bypass Connection | |
| 55 | EZV17 | O-ring JASO #1017 | |
| 56 | EM192 | Fastener "16A" | TK2,TKD20,TKJr,TK1S,T-K3, OS,SP,TH1,Pro |
| 57 | EM193 | Heater fixing Plate | |
| 58 | EW009 | Screw M4 x 6 | * |
| 59 | EM143 | Flow Sensor | |
| 60 | EM165 | Heater 102 | |
| 61 | EM194 | Magnetic Protection Plate | |
| 62 | EZN19 | O-ring JASO #1019 | |
| 63 | EW01E | Truss screw M4 x 14 (coated) | * |
| 64 | EM101 | Water Inlet | |
| 65 | EZN21 | O-ring JASO #1021 EPDM (Purple) | TM32,TM50 |
| 66 | EM222 | Filter plug | TM32,TM50 |
| 67 | EM196 | Packing | |
| 68 | EM121 | Combustion chamber | |
| 69 | EM197 | Burner assembly | |
| 70 | EW00J | Screw M4 x 12 | * |
| 71 | EM167 | Wire clamp 60 | TK2, TKD20, TKJr, TK1S, OS, SP, TH1, TM50,TK3, Pro,TM32 |
| 72 | EM198 | Spark electrode holder packing | |
| 73 | EM199 | Rod assembly | |
| 74 | EW003 | Screw M4 x 10 | * |
| 75 | EK068 | Silicon Cap | |
| 76 | EM200 | Spark electrode fixing plate | |
| 77 | EK065 | High voltage igniter cable | |
| 78 | EM201 | Seal packing | |
| 79 | EM202 | Thermocouple | |
| 80 | EM203 | Thermocouple Fixing Plate | |

| Item # | Part # | Description | Common parts for other units |
|---|---|---|---|
| 81 | EM178 | Overheat cut off fuse | |
| 82 | EM159 | Damper | TK2, TKD20 |
| 83 | EM204 | Current plate | |
| 84 | EM205 | Pressure switch port | TK2, TKD20,TM199, TH1 |
| 85 | EM206 | Silicon Tube | TH1 |
| 86 | EKD08 | Pressure switch | TK2, TKD20, TH1 |
| 87 | EM126 | Fan Motor | |
| 88 | EW004 | Hex head screw M4×12 (w/washer) | * |
| 89 | EW008 | Screw M3 x 10 | * |
| 90 | EM142 | Freeze protection thermostat | |
| 91 | EM162 | Manifold LP | |
| | EM158 | Manifold NG | |
| 92 | EM174 | Manifold gasket A | TK2, TKD20, TH1 |
| 93 | EM175 | Manifold gasket B | TK2, TKD20, TH1 |
| 94 | EKK37 | Screw M4 x 12 | * |
| 95 | EKN22 | Manifold pressure port screw | TK1S,T-KJr,T-H1 |
| 96 | EM176 | Gas Coupling | TH1 |
| 97 | EW005 | Hex head screw M4×8 | * |
| 98 | EM177 | Igniter fixing plate | |
| 99 | EM208 | Igniter | TK2, TKD20 |
| 100 | EW009 | Screw M4 x 6 | * |
| 101 | EM123 | Solenoid valve wire | |
| 102 | EM124 | Proportional valve wire | |
| 103 | EM122 | Gas valve unit | TH1 |
| 104 | EZP22 | O-ring P22 NBR (Black) | TH1 |
| 105 | EZP18 | O-ring P18 NBR (Black) | TK2, TKD20, TH1,TK3,Pro |
| 106 | EW00D | Screw M4 x 8 | * |
| 107 | EZP26 | O-ring P26 NBR (Black) | TH1,TM32 |
| 108 | EM125 | Gas Inlet | |
| 109 | EK022 | Gas Filter | TKJr, TK1S |
| 110 | EM209 | Gas Inlet Fixing Plate | |

| Item # | Part # | Description | Common parts for other units |
|---|---|---|---|
| 111 | EM129 (T-M1)<br>EM235 (T-M199) | Computer Board | |
| 112 | EM174 | Computer Board Sticker | |
| 113 | EM134 | Mode Port | |
| 114 | EM173 | Control Box | |
| 115 | EW01D | Screw M3 x 25 | * |
| 116 | EM167 | Wire clamp 60 | TK2, TKD20, TKJr, TK1S, OS, SP,<br>TH1, TM50,TK3,Pro,TM32 |
| 117 | EM216 | Terminal Holder | |
| 118 | EM182 | Surge Absorber: A | |
| 119 | EM183 | Surge Absorber: B | |
| 120 | EW016 | Screw M4 x 16 | * |
| 121 | EM181 | Terminal | |
| 122 | EM136 | Power distribution plate | |
| 123 | EM207 | Ground fault circuit interrupter | TH1,TM32,TM50 |
| 124 | EK055 | Fuse Box | |
| 125 | EM168 | Fuse | |
| 126 | EK057 | Fuse Cover | |
| 127 | EM140 | Remote Control Terminal | |
| 128 | EX012 | Screw M3 x 12 | * |

## 15. Revisions

| Version | Description of changes | Date |
|---|---|---|
| 1.00 | First version | 03/04/08 |
| 1.01 | Revised by the R&D and Takagi Japan | 12/09/08 |
| 1.02 | Revised by the R&D and Takagi Japan | 02/12/09 |